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THE PENNSYLVANIA R. R. TUNNEL under the Hudson River was begun June 25. The tunnel work is divided into two sections, known as the Northern and the Eastern Sections. Chief Engineer Charles M. Jacobs has charge of the Northern section, while Chief Engineer Alfred Noble has the Eastern section. The first drill holes for first shaft were started at noon at the foot of 32d St. and Eleventh Ave., New York.

THE GUNNISON IRRIGATION TUNNEL is to be begun within a month, according to report. The tunnel will cost $2,000,000 and will be in two sections, one two miles long, through a spur in the cliffs, and the other four miles long through the ridge dividing the waters of the Gunnison from those of the Uncompagre Valley, Colorado. Eighty-five miles of irrigation canals will be fed by this tunnel. The section of the tunnel will vary somewhat, but will average 12 × 12 ft. The reclamation act which passed both houses and was signed by the President a year ago provides for this great work. The tunnel will start at a point in the Gunnison Canon, about 12 miles northeast of Montrose.

THE MT. WASHINGTON TUNNEL HEADINGS under Mt Washington, near Pittsburg, have met. The tunnel is 3,000 ft. long, and the second longest on the new line of the Pittsburg, Carnegie & Western R. R., described in our issue of May 21. The bottom bench will be finished in about four months. The Ferguson Contracting Co. is doing the work.

THE NEW WATER INTAKE TUNNEL at Cleveland, O., or rather the portion built by contract, appears to be in bad shape. A recent inspection by Mr. T. H. Murphy, who has been superintendent of construction since the city assumed the work, found portions of the tunnel so full of sand that he was unable to proceed further on his journey.

A 60-FT. VERTICAL BORING AND TURNING MILL at the Schenectady works of the General Electric Co., was described by its designer, Mr. John Riddell, M. Am. Soc. M. E., at the meeting last week of the American Society of Mechanical Engineers. The machine was designed for use in building the largest sizes of electric generators. It rests on a concrete and brick foundation 22 ft. 6 ins. in depth below the floor line. The bed-plate is 20 ft. in diameter and weighs 80,700 lbs., and it has two circular ways having a total bearing surface of 7,730 sq. ins. The maximum load to be placed on these ways is about 300 tons, making a maximum pressure of 77.6 lbs. per sq. in. The table can be turned at a speed of 1 revolution in 1 minute to 1 revolution in 8 minutes. Adjacent to the mill are 14 circular floor plates, and beyond these 15 radial plates, making a complete floor plate surface of 65 ft. diameter. The whole machine weighs 885,620 lbs. It is driven by a 50-HP. variable-speed electric motor, through a train of gearing giving a maximum speed reduction of 1,040 to 1.

A LARGE SHOT was recently exploded in an oil well in the Allegheny oil field. It consisted of 400 quarts of nitroglycerin loaded in 20 shells, each shell being 7 ins. diam. × 20 ins. long. The well was 1,400 ft. deep, and the nitroglycerin was tamped with 30 barrels of water and 75 ft. of oil. The "go-devil" was dropped, but for fully a minute there was no sound, then a column of water rose from the hole to a height of 75 ft., where it spread out. This was followed by a mighty roar and the discharge of oil, rocks and water to a height of 150 ft. This is believed to be the largest oil-well shot on record.

A BIG STEEL RAIL ORDER has been placed with the U. S. Steel Corporation, by the Union Pacific and Southern Pacific Railroads, according to newspaper reports. The order is for 100,000 tons of rails at $28, to be delivered next year.

A SEWERAGE PUMPING STATION is to be built at Jackson Park Ave. and the Baltimore & Ohio R. R., Chicago, to deliver into the intercepting sewer system (Eng. News, May 28, 1903), the sewage from a special low-level sewer system serving the district between 73d and 95th Sts. There will be four horizontal Corliss engines driving vertical shafts with horizontal centrifugal pumps. Two of these will be triple expansion engines driving pump runners 7 ft. 6 ins. diameter; one will have cylinders 8, 13 and 18 ins. diameter, and 24 ins. stroke; the other will have cylinders 9¼, 16½ and 23 ins. diameter, and 30 ins. stroke. The other two will be cross-compound engines, having cylinders 14 × 30 and 28 × 30 ins. There will be nearly 15 miles of brick sewer, 11 ft. to 2½ ft. diameter, costing about $720,000 ($25 per ft. for 11-ft. and $4 per ft. for 2½-ft. sewers); also 461 manholes, $11,525; 608 catchbasins and conections, $21,280; and 12,000 cu. yds. of rock excavation, $24,000. The cost of pumping station and machinery is estimated at $112,830, bringing the total up to $887,000. The plans and estimates have been prepared by Mr. C. D. Hill, Engineer of the Board of Local Improvements, Chicago.

THE ST. PAUL ELECTROLYSIS SUIT has been compromised on the following terms: The suit is withdrawn or suspended, and the street railway company is given until July 1, 1904, to take steps to eliminate electrolytic action. The company will keep the water board informed as to its progress, will pay damages caused by electrolysis meanwhile, and will reimburse the water board for the cost of tests and the services of experts in the case. Mr. John Caulfield is Secretary of the Water Board, and Mr. Thos. McDermott is its attorney.

MUNICIPAL OWNERSHIP OF WATER-WORKS at Augusta, Me., was declared for on June 22 by a popular vote of 1,433 to 209. This means the formation of the Kennebec Water District, and the purchase of the plant of the Augusta Water Co., in accordance with the plan recently adopted or proposed in several other localities in the state. The plan, and action thereunder, was reviewed editorially in Engineering News for May 28, 1903.

THE FALSE WORK COLLAPSED during construction of the bridge now being built over the Allegheny River at Franklin, Pa. Seventeen men were at work when the structure fell; one was killed and five others may die from injuries. The others saved themselves by jumping into the river, where several narrowly escaped drowning.

THE MOST SERIOUS RAILWAY ACCIDENT of the week in the United States occurred June 19 at Chicago, Ill. A trolley car ran into a Belt Line freight train, killing two passengers instantly and injuring ten others, at least two of whom will die. The trolley car brakes refused to work.——A cow ditched a Norfolk & Western R. R. passenger train, June 26, near Marion, Va. The engineer and fireman were killed, but as none of the coaches left the track the passengers were uninjured.

A FREIGHT ELEVATOR DROPPED five stories in the H. J. Heinz Co. plant at Allegheny, Pa., June 29. The cage fell 45 ft. with its load of 23 persons, two of whom were so seriously injured that they are not expected to live. The breaking of a shaft on the first floor caused the accident.

NINETY PASSENGERS WERE KILLED in a train wreck, June 27, on the Bilbao-Saragossa R. R., at Nejevilla River, Spain. Of 300 passengers only six escaped without injury. The train, which was composed of two engines and 16 coaches, was crossing the bridge, when the couplings between the engines broke. The second engine left the track and fell, followed by the entire train, into the bed of the river. The bridge was 50 ft. above the river bed, and the coaches piled up in a mass of splintered wood and iron work.

THE MISSISSIPPI RIVER COMMISSION held a meeting last week in St. Louis to discuss the carrying on of the work of levee building and the following statement was given out in an interview by Mr. B. M. Harrod, M. Am. Soc. C. E., one of the members of the Commission:

The Commission realizes that this year has proven a great victory for the levee work. The flood of 1903 was higher than any previous year, yet only six crevasses occurred, as against 38 during the flood of 1897. Realizing, further, the advantage to be gained by immediate action, the Commission has forwarded a report to the Secretary of War, recommending that half of the appropriation for the fiscal year ending June 30, 1905, and half of the appropriation for the fiscal year ending June 30, 1906, be made available at once. This sum, added to half of the appropriation for the fiscal year ending June 30, 1904, would give the Commission a fund of $3,000,000, available for immediate use.

THE NEW SHIP CHANNEL, known as the Ambrose Channel, which is the main entrance to New York harbor, will necessitate the excavation of 42,000,000 cu. yds. of earth. The channel will be 40 ft. deep, 2,000 ft. wide and seven miles long. At the lower end of the channel a cut is being made 35 ft. deep, 1,000 ft. wide and 1½ miles long. This will form a temporary waterway that will afford relief from such accidents as the recent grounding of the "Deutschland." Contracts are to be let for two new dredges to be used in completing the main channel, and eight months hence, when these new dredges are in commission, the dredging output wil be twice what it now is. It is estimated that the work will cost $24,000,000. Maj. W. L. Marshall, of the Corps of Engineers, has direct charge of the work.

MEASUREMENTS OF THE FLOW of the Colorado River are to be made by Prof. L. G. Carpenter, State Engineer of Colorado, for use in the Kansas-Colorado water suit over the Arkansas River, now pending in the U. S. Supreme Court. An appropriation of $6,000 for this purpose has been made from the $25,000 voted by the Colorado legislature to carry on the suit. It is stated that Professor Carpenter will try to answer some or all of the following questions asked by the U. S. Supreme Court:

Whether Colorado is herself actually threatening to wholly exhaust the flow in the Arkansas River in Kansas?

Whether what is described as the underflow in the bill is a subterranean stream flowing in a known and defined channel, or merely water percolating through the strata below.

What lands in Kansas are actually situated on the banks of the river, and what, either in Colorado or Kansas, are absolutely dependent on water therefrom.

The extent of the water shed or drainage area of the Arkansas River.

The possibility of the maintenance of a sustained flow through the control of the flood waters.

The circumstances, a variation in which might induce the court to either grant, modify or deny the relief sought for, or any part thereof.

THE NEW COAST AND GEODETIC SURVEY PRECISE LEVEL; A POSSIBLE SUCCESSOR OF THE WYE LEVEL.

By John F. Hayford.*

In 1900 there was designed and constructed in the Instrument Division of the Coast and Geodetic Survey, under the direction of Mr. E. G. Fischer, a new type of precise level, which was immediately put into use in the field by that survey. This instrument was designed and a method of observing adopted corresponding closely to that formerly used on the Missouri and Mississippi River Commissions, with a view to securing rapid precise leveling of low cost, but of the former extremely high degree of accuracy. Greater success in this line has been attained than had been hoped for. The results of three seasons' use of the instrument on more than 2,400 miles of leveling have convinced both the writer and the observers who have handled the instrument that these instruments are not only superior to any former precise levels, but that this type of instrument can compete successfully with the wye level type on leveling of any degree of accuracy. The belief that a fair examination of the merits of this type of instrument will lead to its gradual adoption in the place of the wye level has led to the preparation of this article.

The instrument is shown so completely in the accompanying illustrations that little description is necessary;† k is an outer tube serving to protect and support the telescope and not directly in contact with it; m and n indicate details of the forward pivot support of the telescope. The telescope is free to revolve within a limited range about the horizontal line, joining the points of the screws, n. The third point of support of the telescope is the rounded end of the screw p (one hundred turns to the inch), which abuts against a hardened steel piece a, which forms a part of the telescope. The screw p is controlled by the milled and graduated head q. This is a quick leveling screw used to bring the line of collimation of the telescope into the horizontal plane. It is not used for any measurements of small vertical angles. The draw tube of the telescope slides in two bearings, y, a considerable distance apart.

The level vial is fixed relatively to the telescope tube, save for a slight motion of adjustment, and for the sake of putting it as near the line of collimation as possible a portion of the upper part of the telescope tube has been cut away and the vial sunk into the opening. The vial is mounted with great care. The pieces of cork which serve to limit its longitudinal motion are shown at d_1, two of the screws against which the lower part of the vial rests at each end are shown at b_1, and the spring which holds the vial down firmly in position, while at the same time allowing an opportunity for expansion and contraction, is shown at c_1. The screw at f_1, operated with a socket wrench, serves to adjust the level vial to parallelism with the line of collimation.

Rays of light passing upward from each end of the bubble strike the mirror w and are reflected downward and to the left to two prisms contained in the tube shown in section at g_1 of the right-hand cross-section in Fig. 1. Each of these prisms throws an image of one end of the bubble and a portion of the graduation into the eye of the observer at the auxiliary telescope shown in Fig. 3 to the left of the main telescope. The image of the ends of the bubble and portions of the graduation, as seen by the observer, are represented inside the tube g_1 in the lower right-hand view in Fig. 1.

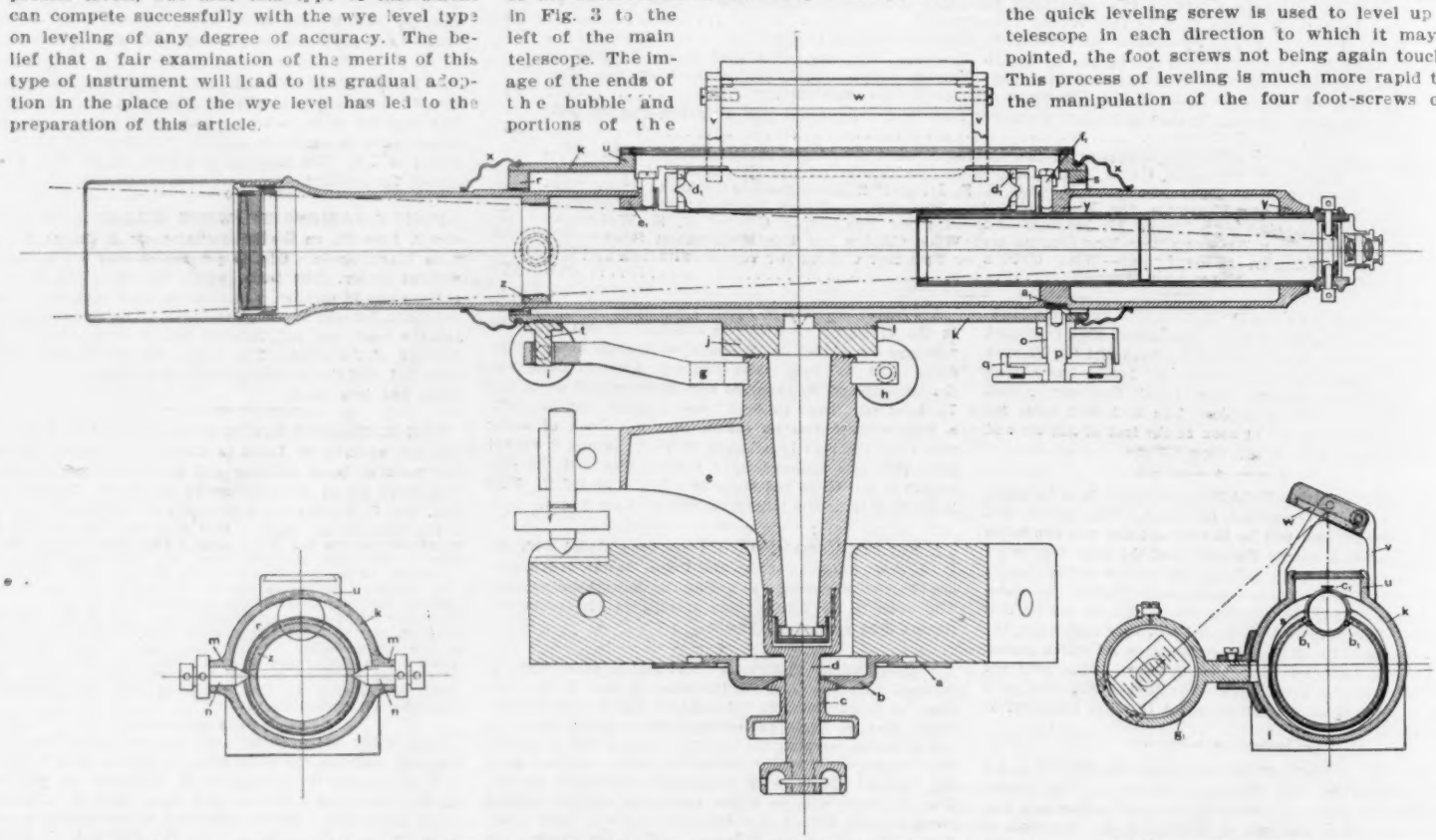

FIG. 1. LONGITUDINAL AND CROSS-SECTION OF PRECISE LEVEL INSTRUMENT; U. S. COAST AND GEODETIC SURVEY.

The instrument has an unusually long center or vertical axis and its center of gravity is very low, both features being conducive to unusual stability. The whole instrument stands very low on its tripod and the area exposed to wind pressure is reduced to a minimum, being less than for a wye level of corresponding optical power. This makes it a stable instrument in heavy winds. It has been used for several days in heavy winds without the wind-shield, which is customary in precise leveling, and no appreciable decrease of accuracy could be discovered, the effect of the wind being simply to delay the observing slightly.

The instrument is of the irreversible type. The level vial is fixed relatively to the telescope, and the telescope itself cannot be rotated about its own axis of figure, nor can it be reversed end for end, except by turning the whole instrument in azimuth. In these respects the instrument is like a dumpy level. It differs from a dumpy level mainly in being provided with a level-reading device and with a quick leveling screw under the eye-end of the telescope.

This instrument is manipulated with great ease and rapidity. The leveling of the instrument is done with sufficient accuracy to bring the bubble within the limits of its graduation by using the spherical level at the side of the telescope, shown in Fig. 2, and the approximate test of the verticality of the axis is made with the principal level. The telescope being then pointed upon a rod for the first reading the bubble is centered and kept centered by using the quick leveling screw. It should be kept in mind that the bubble and graduation are clearly visible to the observer with his left eye at the auxiliary reading telescope at the same time that he sees the rod through the main telescope with his right eye. The final adjustment of the bubble to the center is made almost without loss of time while the rod readings are being taken, without the slightest motion of the observer's head or turning of the eyes, his attention being directed alternately to the image of the rod and the image of the bubble, while he stands in a perfectly erect position. After the first rough leveling of the instrument is made, the quick leveling screw is used to level up the telescope in each direction to which it may be pointed, the foot screws not being again touched. This process of leveling is much more rapid than the manipulation of the four foot-screws of a wye level, and this rapidity is conducive to accuracy as well as economy.

Incidentally, it may also be mentioned that when working over very soft ground or across a railroad trestle, or in any position in which the movement of the observer is liable to disturb the level of the instrument, the bubble of this instrument can be kept centered with less effort than that of a wye level. Precise level lines of the highest degree of accuracy have been carried across long railway trestles without difficulty with this instrument.

A nickel-iron alloy with a remarkably low coefficient of expansion, about equal to that of pine wood, was used in the construction of the outer protecting tube, the telescope, and the mounting of the level vial. This, together with the fact that the level vial has been placed very close to the line of collimation of the telescope, reduces to a minimum the changes in the angle between the level vial and the line of collimation when the instrument is subjected to rapid changes of temperature. It is to be noted also that in this instrument the level vial, which is more sensitive than any other part of the instrument to troublesome distortions due to unequal temperature changes, is very much better protected than it is

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†For a complete description see Appendix 6 of the Coast and Geodetic Survey Report for 1900. See also Transactions of the American Society of Civil Engineers, Vol. XLV, June, 1901, pp. 128-133.

on the wye level. It is here mounted in a dead air space of considerable size, enclosed by metal and glass. It is exposed to a very limited extent only to direct sunlight or direct radiation from the sky or surrounding objects, even if the instrument is used without an umbrella. The umbrella is of course used in the precise leveling to protect the vial and instrument still more fully.

The rods used with this instrument in the precise leveling of the Coast and Geodetic Survey are non-extensible, and are made of pine impregnated with paraffin to such an extent as to render their lengths independent of moisture conditions. Each rod carries a centimeter graduation painted in black and white squares on its front surface. No target is used. It is believed that the direct-reading rod gives greater accuracy, as well as greater rapidity, than the target rod.

The method of precise leveling now used with this instrument is as simple as that of ordinary wye leveling, and it is confidently believed by the observers that the manipulation of the instrument and the observing at each instrument station takes less time than is the case with the wye level and target rods used in ordinary leveling. The observations at a precise leveling station consist simply in reading each of the three horizontal lines of the diaphragm as seen projected against each rod to the nearest tenth of a rod space (1 millimeter = 0.003 foot), while the bubble is held in the middle of its graduation. The mean of the three readings is treated in the computation in the same manner as the single target reading in wye leveling. Certain very small corrections for refraction and instrumental errors are also applied in the precise level computation. These are necessary simply on account of the high degree of accuracy required, but are not due to any peculiarity in the method of observing. They are corrections for errors which exist in the wye leveling as well as in the precise leveling. The so-called stadia constant is in these instruments approximately 1-333, or the subtended interval on the rod is for a 100-meter (= 330-ft.) sight approximately 3-10 meter or 1 ft. The three rod readings are certainly taken in less time than a rodman and observer can make a single accurate target setting and reading.

The only adjustment of the instrument which is made in the field is that necessary to insure that the level vial is parallel with the line of collimation. This adjustment is tested daily by a modification of the well-known peg method to suit it to this instrument. The test takes but little more time than the occupation of a single station in the ordinary course of the leveling, let us say from five to eight minutes. If the adjustment is found defective, it takes less than a minute to correct it. As a matter of experience it may be stated that adjustments from three days to three months apart have sufficed under field conditions to keep the angle between the level vial and the line of collimation less than twelve seconds of arc nearly all the time, and less than four at least half the time. The loss of time in testing and making adjustments with this instrument while being used for leveling of the highest degree of accuracy is probably not greater than with a wye level in use on railroad location for example.

A party for precise leveling in the Coast and Geodetic Survey consists of an observer, recorder, two rodmen, and two hands for extra labor and especially to protect the instrument from the sun and wind with an umbrella and a wind shield. Nearly all the leveling is done along railways. Velocipede cars are used to transport the party to and from work, and even to transport them between instrument stations on all railroads which grant the necessary permission to the Survey parties. This use of velocipede cars between instrument stations is of considerable importance on such rapid leveling as that indicated in this article, in which otherwise nearly one-half the time of the party would be spent in walking.

The claims made in this article are based upon three years' experience by various observers in running over 2,400 completed miles of leveling. The conditions as to grade have varied from the mountainous divisions of the Union Pacific in Wyoming, and even cross-country lines to triangulation stations on hilltops, to the level track of the New York Central between New York and Albany. The weather conditions have included temperatures as low as the freezing point in Wyoming in October, and temperatures as high as 53° C. (= 127° F.) in northern Texas in August. Very strong winds were encountered in Wyoming during the fall months. The rate of progress of a party even under the most unfavorable conditions has rarely fallen below 50 completed miles per month, and the average rate has been 66 miles per month (viz., 2,434 miles in 36.9 months). Every mile of progress represents a mile leveled at least twice, once in the forward and once in the backward direction. If the first two results on any section did not check within specified narrow limits the section was re-leveled in each direction, making four trips in all over that portion. The above statements, and those which follow, relative to the best performances of the leveling parties, will serve not only to indicate the great increase which has been made in the rapidity of precise leveling, but also to outline for the advocates of wye leveling the rapidity with which they must manipulate their instruments on rough work to substantiate any claim that the wye level is capable of doing quicker work than the instrument now under consideration. The following instances of rapid leveling occurred in the regular course of the field work. For every case except that given in the following paragraph similar examples closely approaching it can readily be found by searching the records.

Between April 3, and November 18, 1902, Mr. W. H. Burger ran 640 completed miles of leveling between Anthony, Kan., and Shreveport, La., his average rate of progress being 85 miles per month. This period included two months of very hot weather, during which many miles were run with the thermometer buried in the wooden rods reading more than 40 degrees Centigrade (= 104 degrees Fahrenheit). For comparison with other leveling of the same grade of accuracy it may be noted that recent leveling under the Mississippi River Commission was done at the rate of 38 completed miles per month,* and under the Lake Survey at about 40 miles per month.

Similarly it may be noted that whereas leveling of the same grade of accuracy by the Mississippi River Commission and by the Lake Survey has cost from $14 to $24 per completed mile in recent years, and earlier even more than that; the cost of the 2,400 miles of leveling now under consideration had been from $7 to $11 per completed mile, the cost of the particular line referred to in the preceding paragraph being $6.70 per mile.

During the month of June, on the line from Anthony to Shreveport, by Mr. Burger, 105 miles were completed. The leveling proceeded on 25 days during the month and the total length of single line was 223 miles, or an average of 8.9 miles of single line per observing day. This feat was not accomplished by extra long hours of leveling. Making no allowance whatever for any delays or interruptions except the stop in the middle of the day for lunch, the average number of hours of leveling was 7¼ per day, and the average speed was therefore for the whole month 1.2 miles of single line per hour during the progress of the leveling. The average length of sight during this month was 274 ft. (83 meters).

The party under Mr. W. C. Dibrell ran 103 completed miles during the month of July, 1902, a remarkable record when it is considered that the party encountered many heavy grades on this work in Wyoming.

On July 29, 1902, Mr. Dibrell ran 15.8 miles of single line, none of which was afterwards found to need re-running. The observing was done in 9 hours and 40 minutes, making no deductions for delays, except the dinner hour, or at an average rate of 1.6 miles per hour. The total number of instrument stations on this day was 147. Assuming that the observer moved from station to station on the velocipede cars at an average speed of six miles per hour the time actually spent at the stations was 7 hours and 2 minutes, or 2.9 minutes per station. This includes the time of leveling up the instrument and making other manipulations as well as the observations, being the interval from the instant the instrument struck the ground until it was picked up again.

Similarly, the same observer a few miles east of Rawlins, Wyo., ran four miles of levels, none of which required re-running, in 1 hour 53 minutes, or at the rate of 2.1 miles per hour.

All of the cases of rapid leveling just cited occurred on precise leveling of the highest degree of accuracy. Of the leveling done with these instruments, lines of an aggregate length of 2,050

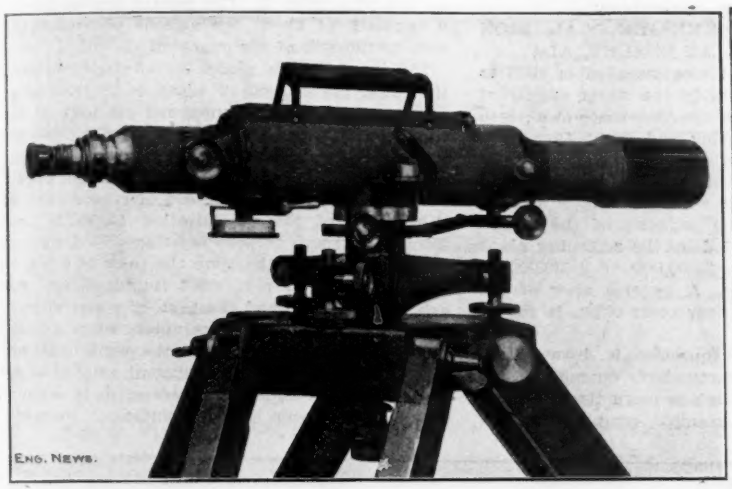

Fig. 2. View of Right Side.

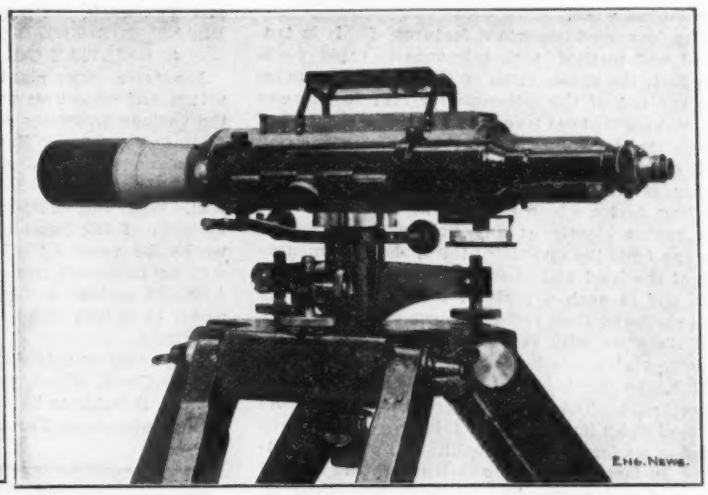

Fig. 3. View of Left Side.

PERSPECTIVE VIEWS OF U. S. C. & G. S. PRECISE LEVEL INSTRUMENT.

*See Trans. Am. Soc. C. E., Vol. XLV., June, 1901, pp. 113-114, 174-175, 179, 187-188.

miles now form portions of closed circuits. The adjustment of closures of these circuits furnishes the severest possible test of the accuracy of the leveling. The greatest correction yet found in any of the lines run with these instruments is 0.073 millimeters per kilometer (0.00039-foot per mile), and on more than half the lines the necessary correction to close all circuits is less than 0.020 millimeters per kilometer (0.00010-foot per mile). This is as good a record for accuracy as has ever been made on any large scheme of precise leveling so far as the writer is aware.

In actual service it has thus been shown that this type of precise level will do extremely accurate work at such a rate as at least to make it a formidable competitor in speed with the wye level doing the ordinary grade of work. What record for speed would it make if it were modified to adapt it to the moderate degree of accuracy required of the wye level, and if the method of observation were also so modified? Every observer who has used this type of instrument believes that under these conditions the leveling would be done much more rapidly and economically than is possible with the wye level, and that such a modified instrument would pay for itself in wages and salaries saved in a few months of continuous work.

The four most important features of this instrument and method, with reference to rapid work, are first, the substitution of a single screw under the eye-end of the telescope for four foot-screws for making the final leveling of the instrument, and hence the possibility of very rapid manipulation and of easily holding the bubble centered even under difficult conditions; second, the use of a reading device which enables the observer to see the bubble clearly at any time without moving his eye from the eye-piece; third, the firm mounting of the level vial nearly in the line of collimation and in such a position that it is unusually well sheltered from rapid changes of temperature, and therefore with the result of securing an unusually stable relation of the vial and telescope; fourth, the use of direct-reading rods instead of target rods. These features can each be incorporated in an instrument of this type for ordinary leveling under ordinary conditions, without difficulty. In fact to adapt the instrument and method to rapid and economical leveling, furnishing all the accuracy required in railroad construction work, sewer construction, surveys for water supplies, or any of the many uses to which the wye level is ordinarily put, but slight modifications are necessary. The telescope being retained with its present power much longer sights could be obtained than is allowable in precise leveling. The sensitiveness of the bubble should be reduced from its present value, one division (2 millimeters) equal to 2 seconds, to such an extent as may be necessary to enable the observer to hold the bubble in the middle of the graduation when no umbrella is used. Certain slight modifications might be made in the design to protect the bubble still further from direct sunlight, on the supposition that no umbrella is to be used. Certain slight modifications would also be desirable so as to furnish the observer a means of more quickly adjusting the instrument again in the field after an accident than is possible in the present design. The observing party may be reduced to four, three or two men, according to the character of the work. If these changes are made there is no good reason to doubt that there will be any difficulty in greatly reducing the cost of ordinary leveling just as the cost of precise leveling has been reduced.

The impression may exist that this type of instrument is necessarily much more costly than a wye level. One of this type of precise levels designed for the highest degree of accuracy was recently sold by a reputable instrument maker, Mahn & Co., St. Louis, together with two rods of the C. & G. S. type, for $350.* This being the price now of the precise level of this type when there is very little demand for the instrument, because it is unknown to most engineers, the price of a lower grade instrument of this type for ordinary work, if they were sold in large numbers, as the wye level is now sold, would not be much if any greater than the present price of the wye level.

The writer firmly believes that a fair examination and test by engineers generally of the merits of this type of instrument for ordinary leveling would lead to the gradual but complete displacement of the wye level. Fair and sufficiently extensive trials will lead inevitably to the conclusion that to use a wye level is to throw away time and money.

In conclusion, the writer wishes to state that he is not financially interested in any way in this type of level. This article is written in the hope that it may help to advance the interests of the engineering profession by reducing the cost and raising the standard of ordinary leveling.

*Saegmueller, of Washington, is also manufacturing these instruments, and possibly there are still others from whom they can be obtained.

FOUR SYSTEMS OF SOFTENING WATER FOR INDUSTRIAL PURPOSES.

Water softening plants are now being installed on every hand. Nearly all of them treat water for industrial purposes only, but a few have been put in on city supplies, and more of these will doubtless be added in the near future. Below will be found descriptions of four systems, on the Pittsburg, New York-Continental-Jewell, Breda, and Tweeddale systems, respectively.

PLANT FOR THE TENNESSEE COAL, IRON & RAILWAY CO., AT ENSLEY, ALA.

A notably large plant was installed in 1902 to soften and otherwise purify the water supply of the various industries of the Tennessee Coal, Iron & Railway Co., at Ensley and Pratt City, Ala. The plant is designed to serve a boiler capacity of 25,000 HP., only 17,000 of which is now in operation. With the addition of more boilers and an increase of the pumping capacity of the waterworks the volume treated by the softening plant will be increased from 2,500,000 or 3,000,000 to 4,000,000 gallons a day. A general view of the plant, as it was when near completion, is shown by Fig. 1.

The water supply in question is drawn from Village Creek, which, particularly during the dry months, is liable to be high in incrusting and corroding substances. For example, samples analyzed in September, 1902, by Dr. J. M. Harris, Chemist to the company, showed the following results in grains per U. S. gallon:

Sodium chloride	3.67
Calcium sulphate	12.47
Magnesium sulphate	11.00
Silica	4.02
Iron sulphate	6.53
Organic matter	1.92
Free sulphuric acid	0.81
	45.42

In the winter and early spring months the calcium sulphate rarely exceeds 6.52 grains and the magnesium carbonate 3.38 grains per gallon, while at the same time the organic matter is low and there is little or no indication of free sulphuric acid. The latter, when it does appear, is due to the pollution of the creek by manufacturing plants, the discharge from which, at low water, may suddenly change the water from a condition of alkalinity to acidity.

A small laboratory at the softening plant enables the operator to determine, by simple tests, the varying character of the water and to regulate the quantity of chemicals accordingly. A single test of the treated water, made in September, 1902, showed that the calcium sulphate had been reduced to 0.81, and the magnesium carbonate to 2.39 grains per gallon.

The water is treated with lime oxide and sodium carbonate in large precipitating tanks and then passed through gravity mechanical filters.

PREPARATION OF CHEMICALS.—The precipitating agents employed are lime and soda ash. The solutions are prepared in separate tanks, in duplicate, each tank having a capacity of 600 gallons. There are also two solution pumps, one between each pair of tanks, as shown on the plan, Fig. 2. The pumps are speeded to a capacity of about ten gallons per minute, or less, at the will of the operator.

The lump lime is placed in a receptacle inside the tank, the bottom of which is of wire gauze, so as to prevent any unburned portions of lime from passing through. After it is slaked the finer particles are washed to the bottom of the tank, where a cream of lime is formed, and kept in constant agitation by the aid of compressed air. While one of the precipitating tanks is being filled, this cream of lime is being added with the water, so that by the time the tank is filled, the lime solution has performed its functions. Soda ash is then added and the tank of water violently agitated for about seven minutes, when a test is made to determine whether the water has been properly treated. If an insufficient amount of material has been added, the correction is made; if an excess has been added, a sufficient amount of raw water is turned in to correct this evil. A record of this test is then made, giving the amount of material used, and the date and hour when this tank was treated.

PRECIPITATION TANKS.—There are four steel tanks, 30 ft. in diameter and 30 ft. high, each having a capacity of 160,000 gallons excluding the cone-shaped bottoms. The tanks are supported, as shown by Figs. 1 and 2, on steel columns, 10 ft. high, thus making room for the coni-

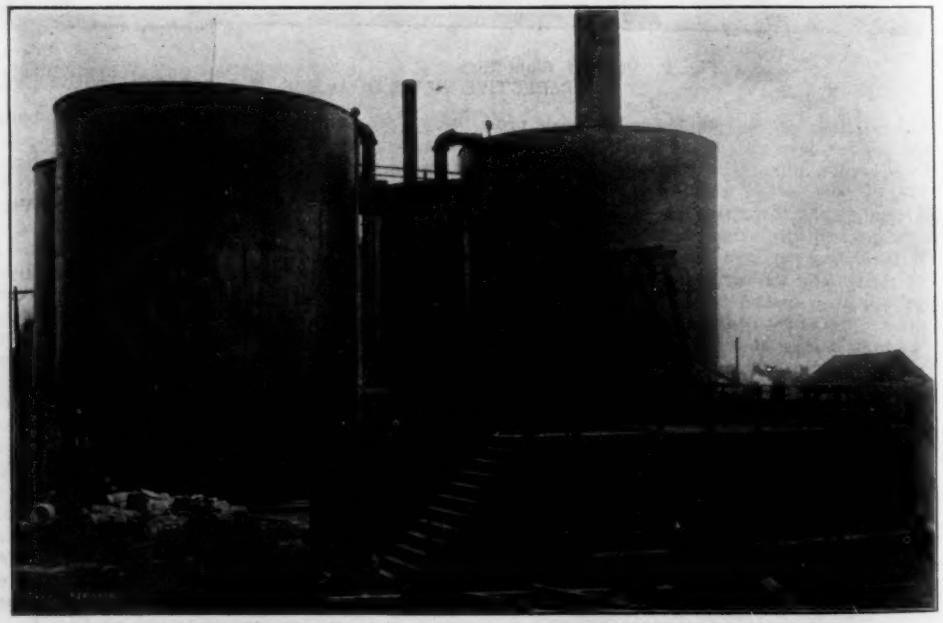

FIG. 1. GENERAL VIEW OF WATER SOFTENING PLANT FOR THE TENNESSEE COAL, IRON & RAILWAY CO., ENSLEY, ALA.
Pittsburg Filter Mfg. Co., Pittsburg, Pa., Contractors.

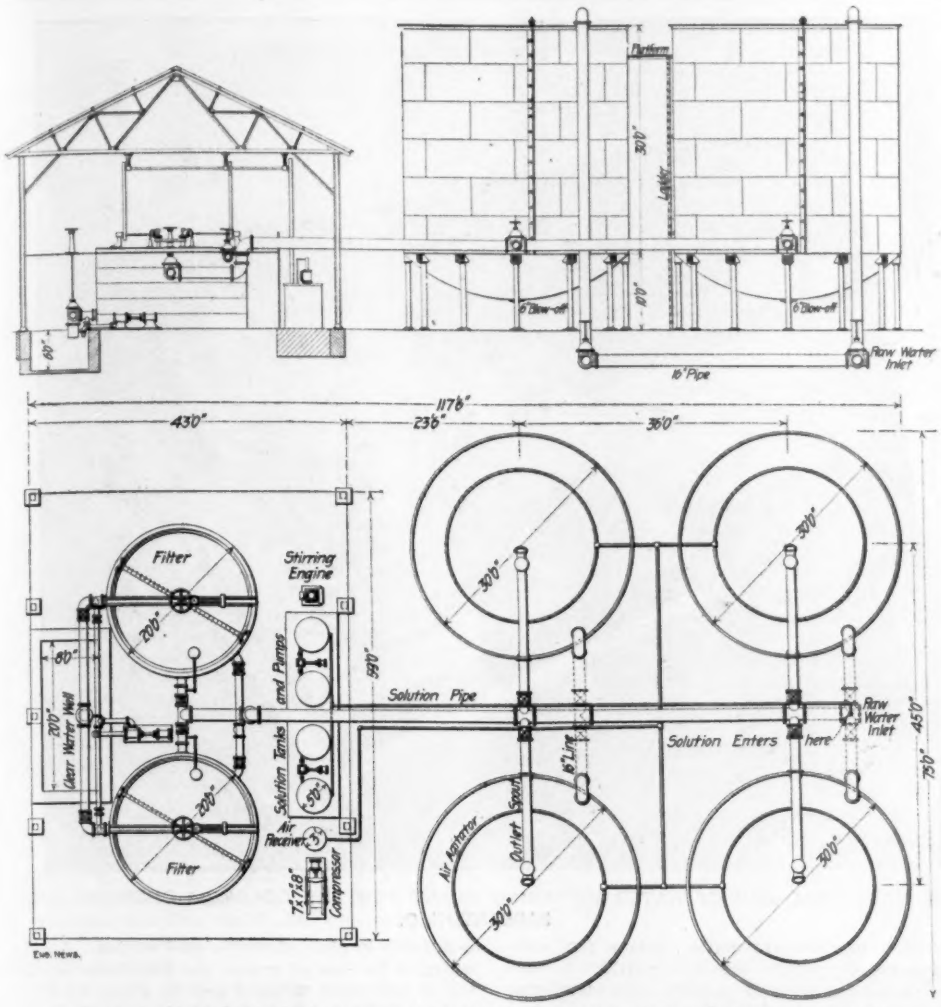

FIG. 2. PLAN AND SECTIONAL ELEVATION OF ENSLEY WATER SOFTENING PLANT.

cal bottoms, which are used to collect and draw off the sludge. Each tank is filled through an independent line of 16-in. pipe, provided with connections for introducing the chemical solution without interfering with any other tank. After being filled, the water and chemical in each tank are thoroughly mixed by means of air under 10 to 15 lbs. pressure, introduced through the side of each tank, and distributed through a perforated pipe, in the form of a ring. This pipe is 8 ins. above the chemical inlet. The air is furnished by an 8 × 8 × 10-in. straight line air compressor, supplemented by a receiver 30 ins. in diameter and 10 ft. high, in which a pressure of 10 to 20 lbs. is maintained. After the water has stood from one to four hours in one of the tanks, the operator opens the valve in the outlet pipe, which is connected to a movable pipe in the tank, the latter always being maintained at 12 ins. below the surface of the water. The clarified water is drawn off to within one foot of the cylindrical portion of the bottom of the tank. When the clear water has been drawn off, the sludge which accumulates in the cone bottom is flushed out to the sewer about once in four to six days.

FILTERS.—There are two mechanical filters of steel construction, 20 ft. inside diameter, and 8 ft. high outside, with an effective filtering surface of 318 sq. ft. in each. Between the top of the shell and the filtering surface, there is an iron trough from which the water is evenly distributed to the filter bed, over a circular weir. A spring tooth revolving rake is provided (see Fig. 3) for stirring up the sand when the filters are washed, and a centrifugal pump having a capacity of 1,000 gallons per minute is used for washing out the filters about once in seven days.

Underneath the filters is a clear water reservoir having a capacity of 18,000 gallons, from which the centrifugal pump lifts its supply of filtered wash water.

All parts of the plant are accessible from the ground, and gages and electrical enunciators show when each precipitating tank is filled within 12 ins. of the top, by ringing a bell, so that there is no danger of a tank overflowing.

The plant was designed and built by the Pittsburg Filter Manufacturing Co., of Pittsburg, Pa., under a contract calling for a removal of 90 to 95% of the salts of lime and magnesia, regardless of their form, and also of all corroding substances. Mr. J. B. Greer is manager of the Filter Co.

PLANT FOR THE COLUMBIA CHEMICAL CO., BARBERTON, O.

A softening plant, with a capacity of 20,000 gallons of treated water per hour, or 480,000 gallons per day, was put in operation late in 1902 to supply water for the power plant of the Columbia Chemical Co., of Barberton, O. Fig. 4 is a general view of the plant from above, taken before it was enclosed. Fig. 5 includes a plan and section, and Fig. 6 is a more detailed section of the lime tank.

The water is treated with lime and soda, passes to a precipitation tank, then to a gravity filter, located in the precipitation tank. The agitators used in the large lime and mixing tanks are driven by a water wheel, the power for which is derived from the fall of water to be treated. In general, wood was used in construction, but the small solution tank, water wheel, and regulating tanks are of steel. The lime mixing and precipitation tanks through which the water passes is succession, have a combined available capacity of 105,000, giving five hours' time for the passage of the water through the apparatus, not including the filter.

The plant rests on a solid concrete foundation. Its operations are all controlled from the floor or platform covering the lime and mixing tank, and a portion of the precipitation tank.

PREPARATION OF THE CHEMICALS.—The water enters the plant through an automatically controlled inlet valve, passes down over the water wheel into the receiving tank, shown in Fig. 5, and thence over two weirs. One of these weirs is of fixed size, designed for the full capacity of the plant. Through this weir the main supply flows to a mixing trough. The second weir is of the same depth and level, but it is provided with an adjustable wing, operated by a screw and hand wheel. By these means the flow of water to and through the lime tank may be adjusted at will. The solution of lime water from the lime tank joins the main water supply in the mixing trough, where the two streams pass together over a series of baffle plates. The water with its dose of lime now passes to the bottom of the mixing tank, where the soda solution is admitted through a feed valve, regulated to the flow through the main supply valve. The water with both the lime and soda in it now rises through the mixing tank, where it is constantly stirred by the agitating device shown in the illustrations, and finally flows over an outlet at the top of the tank, and passes

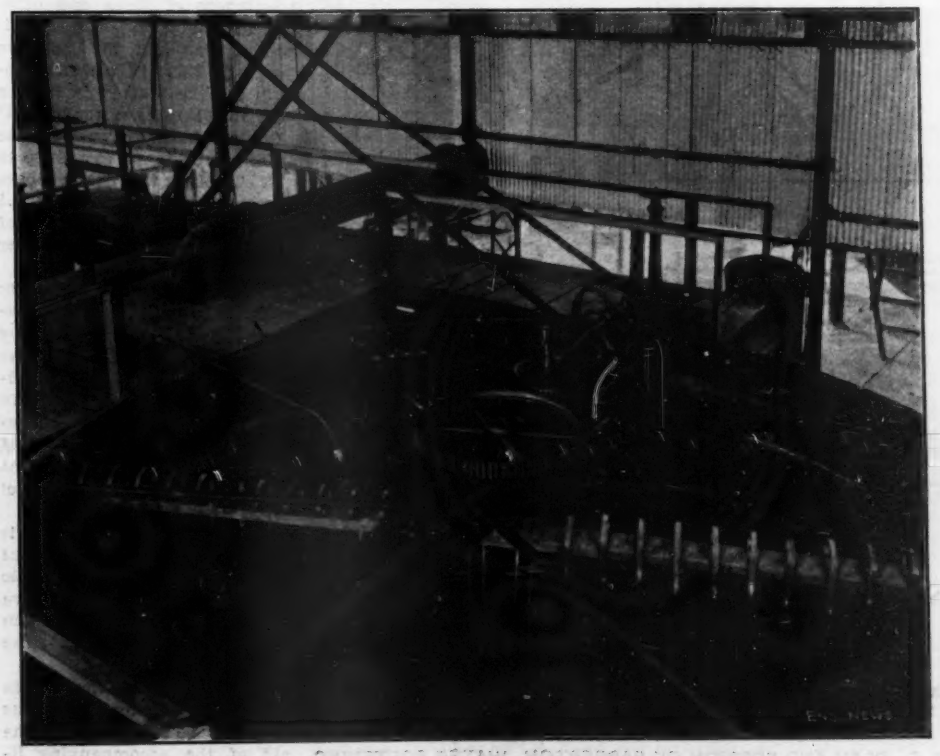

FIG. 3. VIEW OF TOP OF ONE OF THE ENSLEY FILTERS.

to the large precipitating tank. The lime and the mixing tank each has a net capacity of 12,500 gallons.

As shown by Figs. 4 and 5, small tanks are provided above the level of the lime and the mixing tanks just described. One of these tanks is used to slake the lime and the other is employed to make up the soda solution.

PRECIPITATING TANK.—This is 28 ft. in diameter and 20 ft. deep, and has a net capacity of about 80,000 gallons. The treated water enters near the bottom, rises to the top, and flows through ports onto the surface of the filter.

FILTER.—This operates at only 2,000 gallons per sq. ft., or 87,000,000 gallons per acre, has coarser sand than is generally used, and is not provided with agitators for use in washing. The top of the filter tank is on the same level as the top of the precipitation tanks. Gates are provided to close the ports while the filter is being washed. The filtered water flows by gravity to the feed water heaters, and as the supply is taken from condensers no separate pumping is required on account of the water softening plant.

The plant was installed by the New York Continental Jewell Filtration Co., and we are indebted to Mr. F. B. Leopold, of that company, for information used in preparing this article.

THE BREDA WATER SOFTENING APPARATUS.

Two water softening plants have recently been installed to treat water for industrial purposes in Brooklyn, N. Y. The apparatus employed is extensively used in Europe, having been invented and now being controlled there by Mr. Halvor Breda, of Berlin. The chemical reagents employed are slaked lime and soda. The other notable features of the process are the heating of the water to be treated; adjustable automatic devices for controlling the flow of the chemical solutions to conform to the quality and quantity of water being treated; the design of the lime water saturator; and the independent mechanical filter.

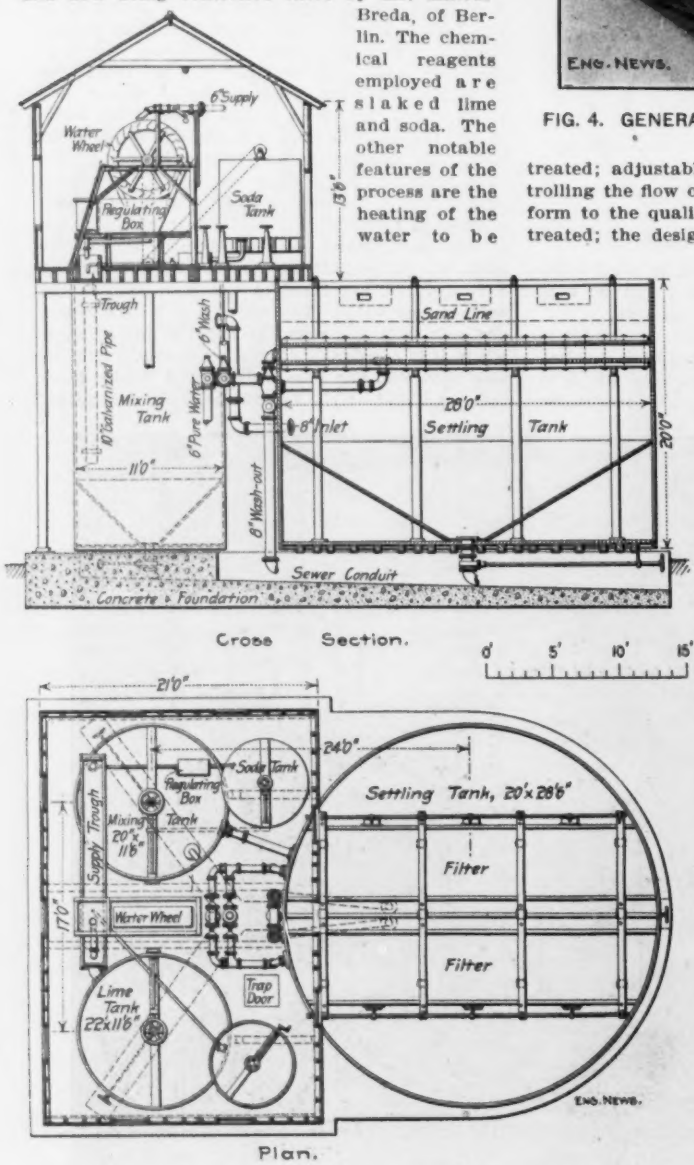

FIG. 5. PLAN AND SECTION OF BARBERTON WATER SOFTENING PLANT.

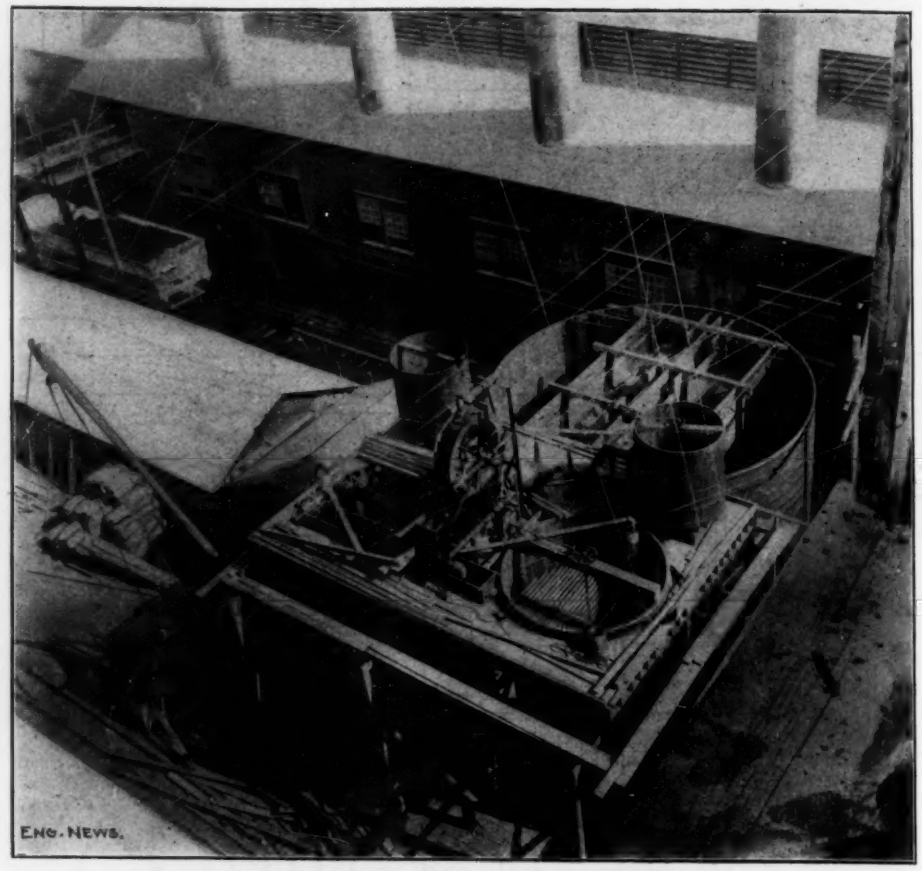

FIG. 4. GENERAL VIEW OF WATER SOFTENING PLANT FOR THE COLUMBIA CHEMICAL CO., BARBERTON, O.

Fig. 7 is a view of a water softening plant with a capacity of 1,050 gallons per hour, or about 25,000 gallons a day, at the factory of Wm. Demuth & Co., Brooklyn, N. Y., manufacturers of pipes and other articles for smokers. This plant was put in operation early in 1902. The water supply for the factory is from a deep well. The water has 16° French hardness, which the plant is designed to reduce to 2°. To effect this change there are required, theoretically, 1.1 lbs. of lime and 0.71-lb. of soda per 1,000 gallons of water softened.

At another and larger Brooklyn plant, put in operation in 1901, to replace one built by another company, the well water treated has a hardness of 30.5°, French scale. To reduce this to 2° there are required 1.4 lbs. of lime and 1.3 lbs. of soda. This plant is at the brewery of Piel Bros.

In general, the water is heated by exhaust steam, but even if that is not available heating entails but little extra expense wherever the water in hand is to be used to raise steam.

The details of the Breda water softening apparatus may now be set forth with the aid of the accompanying illustrations. Fig. 8 shows the apparatus in plan, elevation and section. All the water to be treated enters the distributor at the top of the plant (Figs. 8 and 9) where its force is broken by a perforated plate, and where the volume is divided as desired and sent on its several ways to the heater, the lime saturator, and the tilting tank operating the soda measuring cup. From the bottom of the water heater (Fig. 10) and from the top of the lime saturator (Fig. 8) the water goes to the mixing compartment at the top and in the center of the settling tank. The soda solution and the heated water are also discharged into this mixing compartment. The water and its contained chemicals now flows down to the bottom of the settling tank, then slowly upwards in the outer, clearing compartment, and over a notched circular collecting weir and on through a pipe to the filter. The impurities settle into the sludge hopper and are drawn off at intervals as may be required.

Reverting now to the water distributor, Fig. 9, it will be seen that a movable partition is used to adjust the relative flow of water to the heater and to the other portions of the plant, and that the second and minor stream is divided in like manner, for the supply to the lime water saturator and the tilting tank operating the soda measuring cup.

The general design of the tilting tank is shown by the longitudinal section, Fig. 11. A rod attached to the outer end of the balanced-lever lowers the small soda measuring cup into the soda solution tank every time the tilting tank empties. The weighted lever restores the empty tilting tank to its former position, and at the same time lifts the soda cup, which then discharges its contents through rubber tubing to a pipe leading to the mixing compartment already described. The tank in which the measuring cup operates is kept filled to a constant level by means of a ball cock controlling a supply pipe from a larger tank, which is filled with soda solution daily. The discharge from the tilting basin, five or six times per minute, rushes down a pipe to the bottom of the lime saturator, carrying with it more or less air whereby the lime at the bottom of the tank is agitated. The lime thus stirred rises part way to the top of the tank, but gradually settles back,

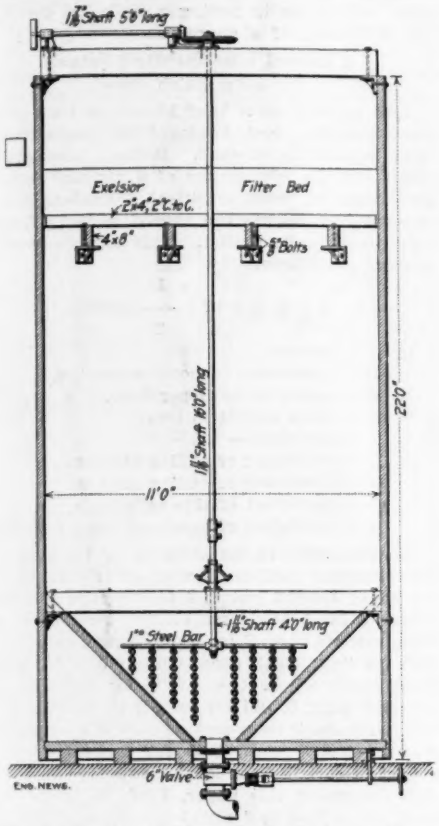

Fig. 6. Section of Lime Tank; Barberton Plant.

leaving only clarified lime water to be sent to the mixing compartment.

The filter is of the mechanical type, with a thin bed of fine gravel, as shown by the section, Fig. 12.

This form of water softening apparatus is built in sizes of from 60 to 16,000 gallons capacity per hour, the latter being the maximum unit size. A large number of plants are in use in Continental Europe. Of notable foreign installations now in progress the largest is one of 16,000 gallons capacity per hour, or 384,000 gallons per day, for the Röchling Iron & Steel Works, Völkingen-on-the-Saar, Germany. This works has already two units of a capacity of 15,000 gallons per hour each, so the new plant will give a combined capacity of 1,100,000 gallons a day.

THE TWEEDDALE WATER SOFTENING AND PURIFYING SYSTEM.

In the description of the new railway shops at Topeka, Kan., in our issue of April 2, reference was made to the use of the Tweeddale system for softening the water used at the plant.

The Tweeddale system is of the intermittent class, and is not automatic in action, both of which features, it is said, are advantageous in regard to efficiency, ensuring greater uniformity in results than continuous and automatic action, which might be arrested by freezing or accident. The process requires no pumps or machinery, and needs only a few minutes attention every six hours, when the fireman or other attendant introduces the chemical solution and puts the aerating jets in operation.

The construction and arrangement of the apparatus are shown by Fig. 13 (on p. 10). Two wooden tanks are used, the water in one undergoing treatment and sedimentation while the treated water in the other is being used. The size of the tanks varies with the capacity of the plant, each holding enough to furnish a supply for from six to eight hours. It is stated that two 50,000-gallon tanks will suffice for a plant of 2,000 HP. boiler capacity. The raw water is carried by a pipe to the bottom of the tank and passes into a chamber filled with coke and iron. From this it escapes into the tank through four radial pipes with curved ends. When the tank is filled to within a few inches of the top, air at about 45 lbs. pressure is admitted through the chamber, escaping through the radial arms and through a ¼-in. hole on the top. The air may be supplied from a compressor, or blown in by a ⅛-in. steam jet, on the principle of the injector. This causes a violent agitation of the water. The oxygen of the air, it is claimed, removes organic and volatile matter, and with the agitation causes a mechanical separation of the solids in the water. In about five minutes, a given quantity of a standardized chemical reagent is poured in, and the agitation continued for 15 minutes. A coagulant is then added, and sedimentation allowed to take place for one or two hours.

The sludge is washed out once in two or three weeks, being allowed to accumulate until it is 5 or 6 ins. deep, as it is claimed that the stirring up of this sludge by the air greatly aids the sedimentation process. The treated water is drawn off at the surface by means of a swinging pipe fitted with a float. The illustration and above description refer to the apparatus required for boiler house plants. For railway water stations, however, only a single treating tank is required, this being placed at an elevation above the ordinary tank from which the engines draw their supply. When the water has undergone its treatment, it passes down through a pipe in a frost-proof casing and up through another pipe into the railway tank, the treating tank being then again filled with the raw water.

The composition and strength of the reagent, and the quantity to be used, depend upon the quality of the water being treated, and a standard solution is made to suit each case. The strength of the solution is determined by the color test. In this way no skilled attendance is required, but there is no doubt that the plants should be kept under supervision by a chemist to see that instructions are properly followed and that the desired results are obtained.

There are 24 Tweeddale plants now in operation, seven of which are in railway service, including four on the Chicago, St. Paul, Minneapolis & Omaha Ry., where its use has effected a saving in expenses for fuel and repairs to boilers. Other reports on economy and efficiency are as follows: The Boston & Denver Consolidated Mining & Milling Co., at Black Hawk, Colo., has had its fuel bill reduced by $600 per month, and its pipes, which were formerly eaten out rapidly by the acid water, now give no trouble. The Union Ice Co., at Los Angeles, Cal., has found a saving in fuel, repairs and cost of water amounting to $469 per month, having formerly had to purchase the water for ice making, while the Tweeddale process enables water from the wells to be used. The plant at the power house of the Edison Illuminating Co., of Topeka, Kan., has been in operation for four years, supplying Babcock & Wilcox water-tube boilers. When first put in service, the boiler tubes had ¼ to ½-in. of scale, to remove which a rotary boring machine was formerly used. For the first few weeks, the boilers were blown off once or twice a day, to remove the old scale which became dislodged from the tubes and shells. After this no new scale formed. A new boiler was put in operation Nov. 2, 1899, and had not been washed out up to June 25, 1900, at which time an examination showed that the tubes were perfectly clean. In May, 1902, the company's superintendent, Mr. C. R. Maunsell, stated that

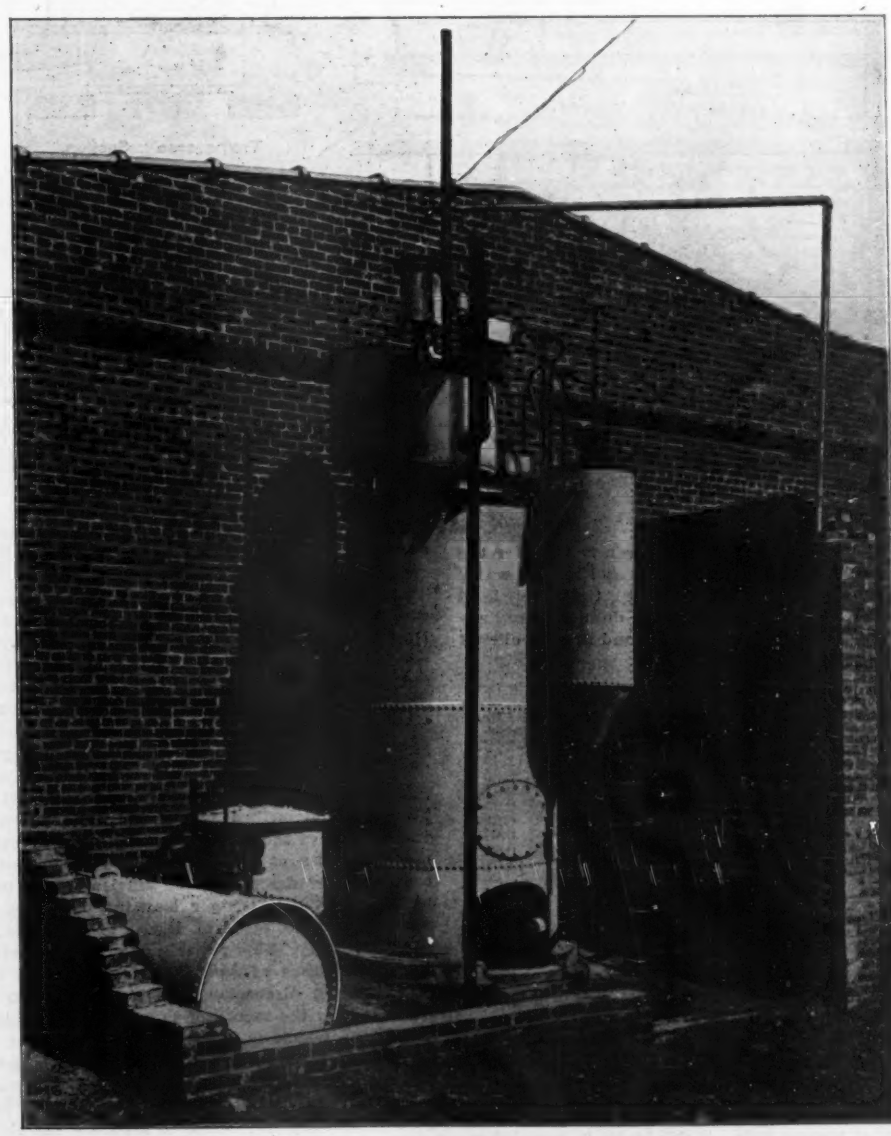

FIG. 7. VIEW OF BREDA WATER SOFTENING APPARATUS AT FACTORY OF WM. DEMUTH & CO., BROOKLYN, N. Y.

the use of the system had saved at least $125 per month in fuel and repairs, and that it had saved its cost in the cleaning of boilers alone. At this plant the water is treated with a solution of hydrate of soda, and chloride of iron is used for the coagulant. Analyses of the raw and treated water are given below; it is remarked that the alkali solids are non-incrusting, and do not harm except by concentration, making mud in the boiler if not washed out frequently.

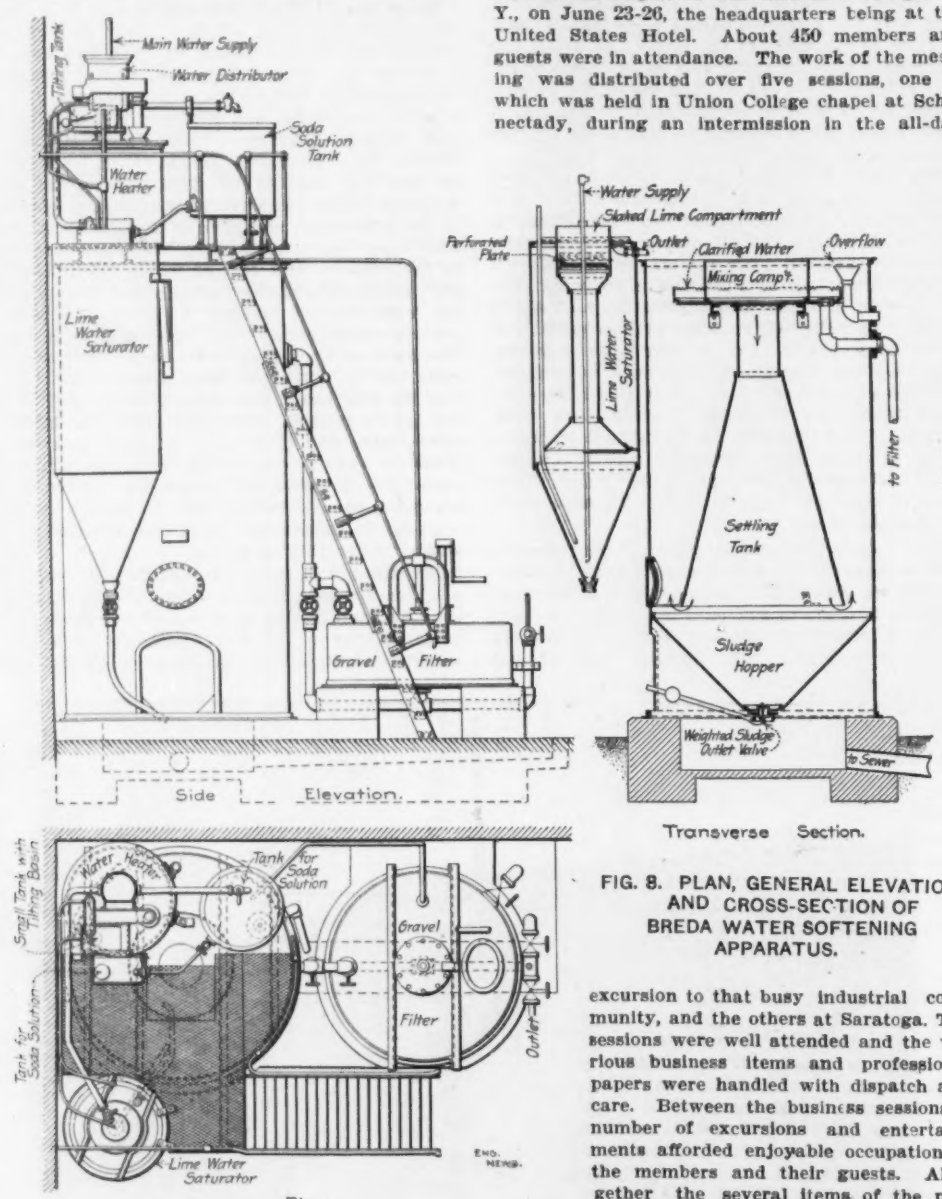

FIG. 8. PLAN, GENERAL ELEVATION AND CROSS-SECTION OF BREDA WATER SOFTENING APPARATUS.

	Analysis, grains per gallon.	
	Before treatment.	After treatment.
Carbonate of lime	17.20	2.23
Carbonate of magnesia	10.05	1.45
Sulphate of lime	15.26	0.00
" of magnesia	0.00	0.51
" of iron	0.56	0.00
Silica	4.42	0.61
Oxide of iron	0.00	0.09
Organic matter	3.03	0.00
Alkali solids	20.33	21.51
Total solids	70.85	26.40
Total incrusting solids	50.52	4.89

The process was invented and patented by the late Mr. William Tweeddale, of Topeka, Kan., who devoted several years to the investigation of methods for water softening. Since his death in 1900, it has been in the hands of Mr. C. S. Burt, Fisher Building, Chicago, to whom we are indebted for plans and other information.

THE LARGEST WHEEL PIT IN THE WORLD is to be built at Niagara Falls. It will be 480 ft. long, 180 ft. deep, and 27 ft. wide, cut through rock. The work will cost $1,250,000, and bids have been called for by the Toronto and Niagara Power Co.

THE SUMMER MEETING OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS AT SARATOGA, N. Y.

The 47th meeting of the American Society of Mechanical Engineers was held at Saratoga, N. Y., on June 23-26, the headquarters being at the United States Hotel. About 450 members and guests were in attendance. The work of the meeting was distributed over five sessions, one of which was held in Union College chapel at Schenectady, during an intermission in the all-day excursion to that busy industrial community, and the others at Saratoga. The sessions were well attended and the various business items and professional papers were handled with dispatch and care. Between the business sessions a number of excursions and entertainments afforded enjoyable occupation to the members and their guests. Altogether the several items of the programme left no unoccupied time, and if any one present suffered ennui it was not because of "lagging hours of idleness."

The work of the convention as a body was introduced by a speech of welcome by Mr. A. L. Rohrer, Chairman of the Local Committee, and an acknowledgment of it on behalf of the visiting members by Mr. James Mapes Dodge, the President of the Society. Following the President's remarks, the Secretary, Prof. F. R. Hutton, read the paper prepared by Mr. J. M. B. Scheele as a guide to the members intending to visit the United States Army gun factory at Watervliet, N. Y. This paper described very briefly the character and purpose of the factory, the nature of its equipment, and its capacity. Mr. R. P. Bolton then read a paper describing the efficiency test made by him of the passenger elevator plant for the new department store of R. H. Macy & Co., of New York city. This paper was printed nearly in full in our issue of June 25. Mr. Geo. Hill, in a brief written discussion, criticised the paper for being merely the record of tests made under ideal conditions which in no way disclosed what the efficiency of the plant would be under actual working conditions. Mr. Bolton replied that under the conditions of actual working it would have been practically impossible to separate the elevator plant from the other elements of the power plant, and that a test under ideal conditions was exactly what general practice considered allowable and proper in testing a device to determine its fulfillment of a guarantee.

A Rational Train Resistance Formula.

By John Balch Blood.

This paper gave a brief history of train resistance formulas, and discussed the characteristics and limitations of each. It then proceeded to point out the advantages of a rational formula, as compared with empirical formulas, and to present and discuss the special rational formula advocated by its author. This formula was expressed as follows:

$$R = A + B\,M + \left(C + \frac{D}{T}\right) M^n$$

In this formula,

R = resistance in pounds per ton,
M = speed in miles per hour,
T = train weight in tons,
n = exponent = 1.8,
A = coefficient of sliding friction,
B = coefficient or rolling friction,
C = coefficient of side resistance,
D = coefficient of head and stern resistance.

The numerical values assigned by the author to these various coefficients were as follows: A = 3 for heavy freight trains; 4 for average passenger trains; 5 for heavy large electric cars; 6 for medium electric cars; 7 for light electric cars. B = 0.15 for light track construction; 0.12 for heavy track construction. C = 0.0016 for ordinary constructed cars; 0.0014 for cars with vestibules. D = 0.25 for small cross-section cars; 0.3 for medium section electric cars; 0.35 for large electric or suburban cars; 0.4 for largest express trains.

In discussing this paper, Prof. H. Wade Hibbard stated that he doubted the absolute accuracy of the formula presented, and also doubted whether it were practicable to develop a formula accurate for all cases. He then instanced a number of the variable factors which influenced train resistance, and which he considered were not taken into account by the formula. He thought that while the formula might be of use for purposes of comparison in connection with other formulas, it should not be employed with the idea that it gave determinations of anything like absolute accuracy.

The Union Engineering Building.

The action which the Council of the Society took shortly after the announcement of Mr. Carnegie's proposed gift of a union engineering building has already been made known to our readers. This action was, in substance, the acceptance of the generous offer and the appointment of a suitable committee to conduct the necessary negotiations. At this meeting the Council laid its action formally before the Society for discussion, with a full explanation of the character and purpose of the gift, and of the steps which were necessary to make it available. In action upon this report of the Council the meeting passed by unanimous vote and without discussion the following series of resolutions:

The American Society of Mechanical Engineers, assembled in general session at its 47th meeting in Saratoga, N. Y., has learned with the greatest interest of the proposed gift to the profession of engineering by Mr. Andrew Carnegie, Member of the Society, of a million dollars for an engineering building. The Society has also been informed of the action taken by its Council in reference to making this gift available and serviceable to the needs of this Society. Wherefore, be it

Resolved, That this Society desires to place on record its appreciation of the purpose of Mr. Carnegie, in seeking to advance by this means the interests of the profession of engineering,

Resolved, That by embodying this purpose in the form of a great and noble building for the uses of those organizations whose aims are to foster the development of engineering, the donor has taken a step which will notably advance these interests;

Resolved, That the Society approves the prompt response of its Council to the opportunity offered to favor and further the interests of the Society which are involved in that progress of the profession which lies at the base of the Carnegie gift.

Resolved, That it be referred to the Council with power to transmit by cablegram and letter to Mr. Carnegie the action of the Society, and to carry out by further action the details necessary to realize Mr. Carnegie's generous purpose.

Results of the Letter Ballot on the Metric System.

It will be remembered that one of the results of the active discussion of the metric system of weights and measures at the annual meeting of the Society held in New York city last winter was a vote ordering the Secretary to send out an informal letter ballot to ascertain the opinion of the Society membership upon the advisability of adopting the system as a standard in America. This ballot was sent out in due order, and from the votes received the Secretary had compiled a table showing their character in detail. The number of votes received constituted about 20% of the total voting membership of the Society, and the following are the totals as taken from the detailed table:

Item.	Total votes.	Per cent.
For metric system as only legal standard....	103	20
Against metric system as only legal standard.	103	80
In favor of U. S. bill.....	95	20
Against U. S. bill.....	342	80
In favor of some legislation.....	153	33
Against any legislation.....	311	68
Detriment to personal business.....	243	58
Not detriment to personal business.....	145	42
Advantageous to personal business.....	89	..

Mr. Gus. Henning made a motion that the results of this ballot should be stricken from the records of the Society. His reasons for making this motion were that although the vote was an informal one, it would be used by the opponents of the metric system as the formal, official expression of the Society; that only 20% of the members had voted, and their vote was not a fair representation of the opinion of the membership as a whole; and, finally, that but few of those who voted had had actual experience with the metric system and were competent to judge of its advantages and disadvantages. Mr. Henning's motion was vigorously combatted by Mr. F. A. Halsey and others and he finally withdrew it upon the understanding that in printing the table it would be distinctly stated that the vote was an informal expression of opinion and represented only 20% of the voting membership of the Society.

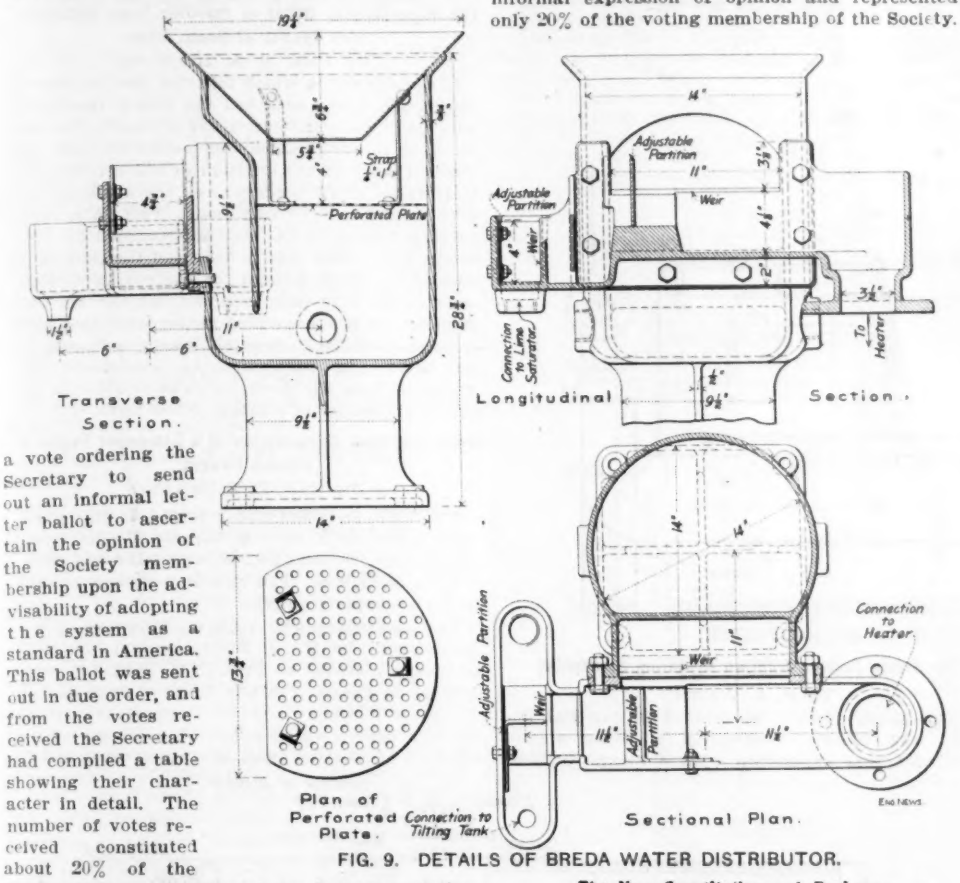

FIG. 9. DETAILS OF BREDA WATER DISTRIBUTOR.

The New Constitution and By-Laws.

The draft of the new constitution, which had been prepared by the committee having the matter in charge and which had been forwarded to all members, was presented by Mr. C. W. Hunt, who explained in some detail the various features of the new document and the reasons which had influenced the committee in drafting the more important new provisions. In conclusion, he moved that the draft be submitted to letter ballot for formal adoption by the Society. In the discussion which followed Mr. Gus. Henning commended the committee in having provided for the organization of "sections" of the Society, made up of members interested in the same specialty, or residing in the same vicinity, and urged further that this provision be emphasized as one of the fundamental objects of the Society by embodying it in the clause formally outlining the objects and purposes of the Society. Mr. Henning's motion was voted down, and by another vote the meeting ordered the draft as submitted by the committee to be voted on by letter ballot.

Turbine Flow Recorder.

By C. W. Allen.

This paper was presented in January, 1903, at a local meeting in New York. The general character of this device will be understood from the following extract from the paper:

> This device records automatically the total quantity of water discharged by the turbine. It really makes a water meter out of the turbine, using the vanes of the turbine as the vanes of the meter, and readings are taken from the dials in the same manner as from the ordinary water meter. In other words, this device records the total quantity of water passing through a given turbine with a variable gate opening and acting under a variable head. In places where the head is practically constant a single-cylinder type of recorder is used, which deals only with a variable gate opening. In places where the head varies sufficiently to be taken into account a second cylinder is used and compensates the final reading for the varying head. In places where the head varies the important question is not how much water is used alone, but how much water and under what head, or, in other words, how much available power is supplied. This last question can be answered by the two-cylinder type of recorder, provided a record of the head is also kept, although a third type of recorder has been devised which instead of registering cubic feet discharged, gives, directly, mill-power hours.

This paper was read by title only and was not discussed.

Some Data on Hoisting Hooks.

By John L. Bacon.

This paper, describing the results of tests made by the author on plain round and Towne section hooks, was printed nearly in full in our issue of June 25. It was discussed by several members, the first discussion being contributed by letter by Mr. Towne, who called particular attention to what he considered the dangerous practice of carbonizing or hardening hoisting hooks. This practice he considered dangerous because it lessened the margin between bending and breaking, and the hook so treated, instead of giving a warning by previous bending, broke suddenly and with danger to those underneath the load. Mr. F. A. Waldron confirmed Mr. Towne's remarks regarding carbonized and hardened steel hooks, and stated that after 15 years' experience in manufacturing crane hooks he was convinced that the only proper material of which to make them was high-grade puddled iron. This was because wrought iron withstood working and heat treatment with less injury than steel, and because such injuries as it sustained were more easily detected than in the case of steel.

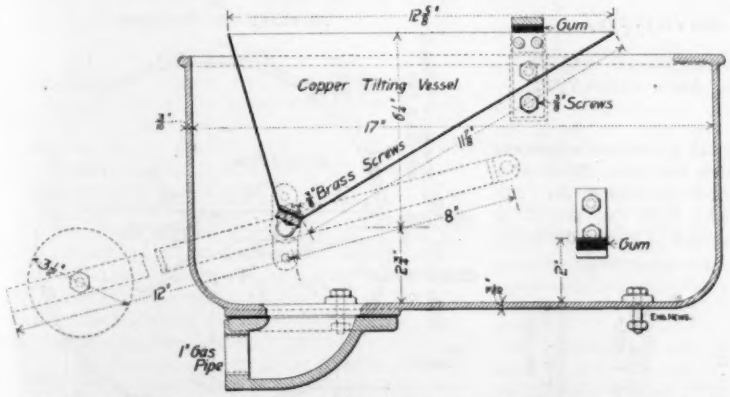

FIG. 11. SECTION THROUGH WATER TILTING TANK OPERATING SODA MEASURING CUP; BREDA SYSTEM.
(For capacities ranging from 3,000 to 5,300 gallons per hour.)

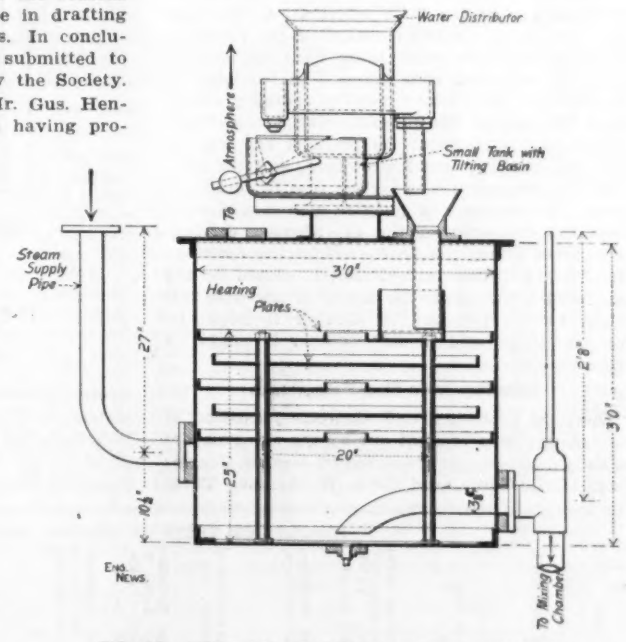

FIG. 10. SECTION OF BREDA WATER HEATER.

Strains Produced by the Excessive Tightening of Nuts.

By A. Bement.

In this paper the author called attention to the well-known dangers resulting from the excessive tightening of nuts, and suggested the desirability

of evolving some practicable means of avoiding it. The paper developed considerable discussion, which turned largely on the suggestion made by Mr. Oberlin Smith, that a series of wrenches be used with different lengths of handles apportioned to the size of the nut, and the average force which would be exerted by the operator. Mr. F. J. Miller considered that any such remedy would fail because the men would either stick a piece of gas pipe on the wrench handle or use a sledge if compelled to use a wrench so short that undue exertion was required to tighten nuts with it.

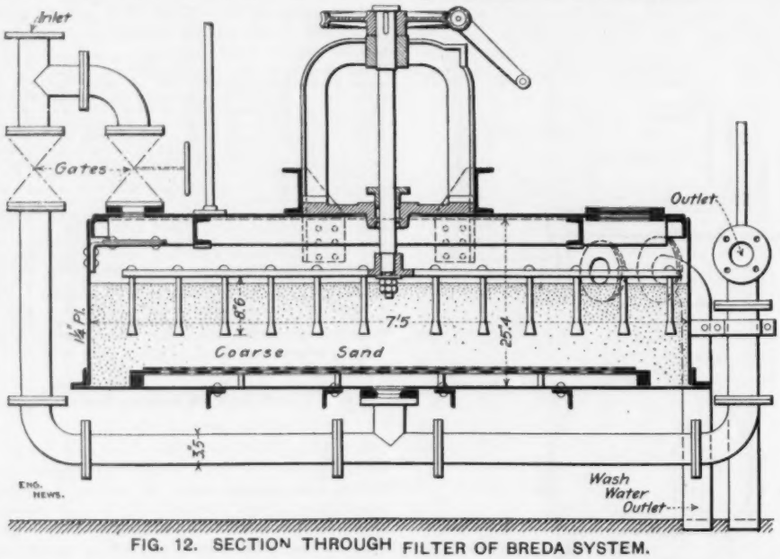

FIG. 12. SECTION THROUGH FILTER OF BREDA SYSTEM.

An Indicating Anglemeter.

By C. E. Sargent.

This paper described a device for determining at sight the angular variation in engine fly-wheel speed. It received no discussion.

Recent Practice in Forcing, Shrinking, Driving and Running Fits and Limits for Limit Gages.

By Stanley H. Moore.

This paper was printed in abstract in our issue of June 25. The discussion was quite active, but it brought out very little information that was new. Mr. A. J. Caldwell compared the formulas given in the paper with those used by himself, with the following conclusions. In running fits the formula gives four times the ordinary allowance; the driving fits recommended are identical with ordinary practice; the pressing fits call for only one-half the usual allowance, and the running fit recommended is far too fine for ordinary work. In response to a question who should settle upon the character of the fit, whether driving, running or other, the draftsman or the foreman, Mr. Fred. J. Miller replied that it should be the man who knew about the work; in one case this might be the foreman, in another it might be the draftsman, and in still another it might be someone else.

Three Papers on Shop Management.

The most prolonged and vigorous discussion of the meeting was brought out by the three papers on shop management presented by Messrs. Charles Day, H. L. Gantt, and Fred. W. Taylor. These papers do not readily endure condensation, and are altogether too long (that by Mr. Taylor occupying 120 pages of the proceedings) to be reprinted in full. The same statement is in the main true of the discussion, which occupied nearly all of one long session of the meeting.

The Steam Turbine from an Operating Standpoint.

By F. A. Waldron.

This paper, which we printed in our last issue, was chiefly interesting in being a record of actual experience with a steam turbine electric generating plant. It gave first a general statement of the facts which led to the choice of a Westinghouse-Parsons turbo-generator for the plant of the Yale & Towne Mfg. Co., and then described the plant, the method of power distribution, and the motors and condensers used. The discussion consisted mostly of questions asked Mr. Waldron concerning certain details of the plant, and brought out little or nothing of general value.

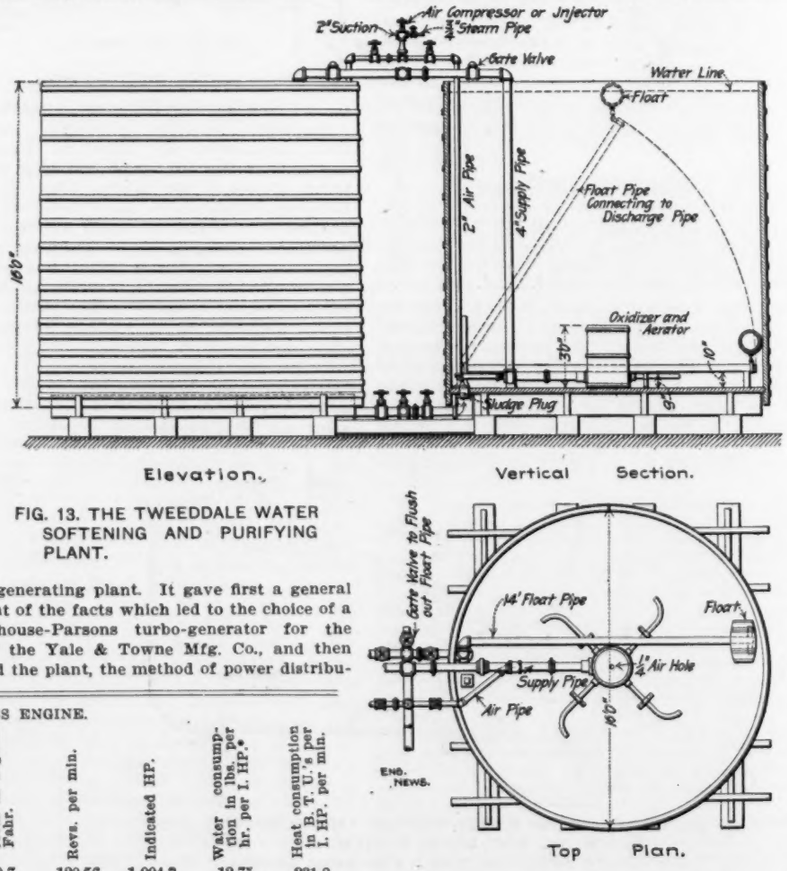

FIG. 13. THE TWEEDDALE WATER SOFTENING AND PURIFYING PLANT.

The Experimental Boiler of the Ohio State University with Results of Some Trials.

By Prof. E. A. Hitchcock.

In the discussion which followed this descriptive paper, Mr. Carey attacked the notion that there was much value in heating the air fed to the furnace. In theory the idea was a very nice one, but when it came to the question of the actual practical value of the procedure all the available figures showed it to be very small. Prof. Wm. Kent called attention to the high unaccounted for heat losses, and stated that it behooved the persons in charge to search around for the reason as they were far greater than were warranted. He also disputed the idea expressed in the paper that local damage was due to very hot gases impinging on the boiler. In conclusion, he condemned the variation from the Society's rules relative to the time and manner of starting boiler tests.

Water and Heat Consumption of a Compound Engine at Various Powers.

By Prof. D. S. Jacobus.

The tests described and recorded in this paper were made on a Rice & Sargent Corliss cross-compound horizontal engine, with 30.03 and 40-in. × 42-in. cylinders. The results were summarized in the accompanying table.

The succeeding two papers, "Drawing Office Equipment," by Mr. J. McGeorge, and "Bursting of Emery Wheels," by Prof. C. H. Benjamin, were printed in abstract in our issue of June 25. In Professor Benjamin's paper a request was made for any figures which might be available on the strength of rotating disks or rings of steel, and in response to this a member presented the following formulas, based on the results of tests: For steel rings, $S = 0.105\ V^2$; for cast-iron rings, $S = 0.097\ V^2$; for solid steel disks, $S = 0.035\ V^2$; for solid cast-iron disks, $S = 0.022\ V^2$, and for emery

RESULTS OF TESTS OF CORLISS ENGINE.

No. of test.	Date of test, 1901, 1902.	Length of test, hours.	Av'ge steam pressure by gage near throttle valve, lbs. per sq. in.	Average vacuum, ins. of mercury.	Average reading of barometer, ins.	Average pressure above zero in condenser in lbs. per sq. in.	Average temperature of engine room in degrees Fahr.	Revs. per min.	Indicated HP.	Water consumption in lbs. per hr. per I. HP.*	Heat consumption in B. T. U's per I. HP. per min.
2	Dec. 27	6.95	148.0	27.65	30.16	1.23	90.7	120.56	1,004.3	12.75	231.8
1	Dec. 26	5.19	149.8	28.22	30.25	0.99	97.8	120.92	853.3	12.33	226.3
4	Dec. 30	8.00	149.9	27.33	29.69	1.16	82.5	121.17	819.6	12.55	229.9
3	Dec. 28	8.75	151.3	28.63	30.37	0.85	96.0	121.52	627.4	12.10	222.7
6	Jan. 2	8.17	150.1	28.77	30.44	0.82	87.7	121.94	491.4	13.92	256.8
5	Dec. 31	7.30	150.1	27.98	29.86	0.92	89.8	122.67	339.7	14.58	267.7
7	Jan. 2	Friction diagrams; dynamo running idle.						122.00	45.0	....	....

*Total including that consumed by jacket and reheater coil.

wheels, $S = 0.032 \frac{E}{250} V^2$; in all of these formulas

V = the peripheral speed in feet per second.

Positive Governor Drives for Corliss Engines.

By A. H. Eldridge.

In this paper the author advocated the use of gearing and sprocket-and-chain to replace belts for driving engine governors. The paper then described two installations, one in which a bevel gear drive was employed and another in which a chain and sprocket arrangement was adopted. Regarding the chain drive the statement is made that it is cheaper than the geared drive, is not affected by the wear of the main bearings, requires less attention, and runs much more freely. Its appearance is not, however, so good as that of the geared drive. This paper received no discussion.

Alternating Current Motors for Variable Speed.

By Walter A. Schlichter.

This paper was printed in full in our issue of June 25; it was not discussed.

Tests of Twelve Horse-Power Gas Engine.

By C. H. Robertson.

This paper described a long series of gas engine tests conducted at Purdue University; gave the results of these tests, and presented a list of some thirty conclusions which had been deducted from them. There was no discussion.

Internal Combustion Engine with Kerosene Fuel.

By H. F. Halliday and G. O. Hodge.

The authors described a rather interesting comparative test with an Otto cycle gas engine to determine its comparative economic performance with gasoline and with kerosene as a fuel. A large number of tables and diagrams were given recording the results of the tests, and as these need to be studied in detail we will merely call attention as an item of practical interest in connection with the keresene motor to the following remark contained among the authors' conclusions:

In order to use the kerosene as a power gas in this engine it was necessary: (a) to atomize it by compressed air, (b) to vaporize the oil, (c) to superheat the kerosene-air mixture about 250° F. on the average.

The paper was briefly discussed by Prof. F. R. Hutton, who called attention to the authors' remarks concerning the preparations necessary to fit kerosene for use in an internal combustion motor, and expressed his belief that with the constantly increasing price of gasoline there would be good reason for looking into the possibility of substituting kerosene for it.

A Hot Well as an Oil Extractor.

By A. H. Eldridge.

This paper is printed elsewhere in this issue. The only discussion was by Mr. A. A. Carey, who described a very similar arrangement which he had employed with substantial success.

Other Papers.

The following papers were read in abstract or by title and were not discussed. "Gas Engine Testing," by E. C. Oliver; "Comparative Oil Tests," by W. F. Parish; and "Test of An 8-ft. Fan Blower," by E. S. Farwell. The last paper we shall print in a following issue.

Excursions and Entertainments.

An unusually full and enjoyable list of excursions and social functions was provided by the local committee for the entertainment of the visiting members during their stay in Saratoga. During the meeting the following places were visited by the members in a body or in groups: Watervliet Arsenal; Spier Falls power plant; American Locomotive Works, and the works of the General Electric Co., at Schenectady; the factory of Cluett, Peabody & Co., at Troy; and a number of other plants. On Wednesday evening an entertainment was given by the Jest and Song Club of Schenectady at Saratoga, and on Thursday evening a reception by the President of the Society and the officers of the Local Committee was held in the United States Hotel.

AN EXAMPLE OF A HOT WELL USED AS AN OIL EXTRACTOR.*

By A. H. Eldridge,† M. Am. Soc. M. E.

Figs. 1 and 2 give the plan and cross-section of a hot-well that has been in successful operation during the past year. The well is divided into three parts: A the common discharge side for the steam condensers, B the discharge side for one steam condenser, C, the hot side, or pump side.

The operation of the well is as follows: The bulk of the condensing water enters at A and overflows, to a cistern, at D. The water from a single jet condenser enters B. The water from this condenser comes from an engine that runs continuously nearly the entire year. Its temperature

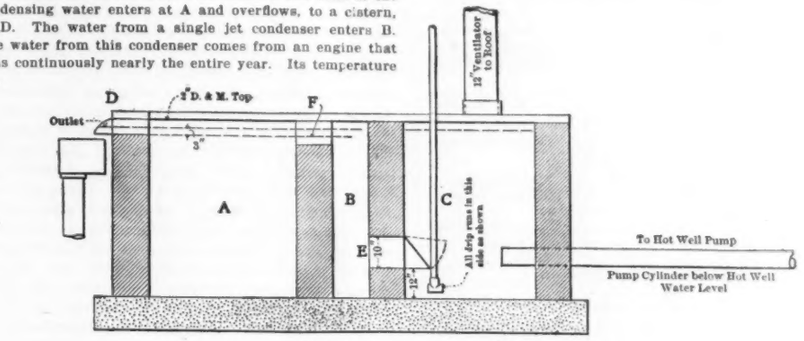

Fig. 2. Transverse Section.

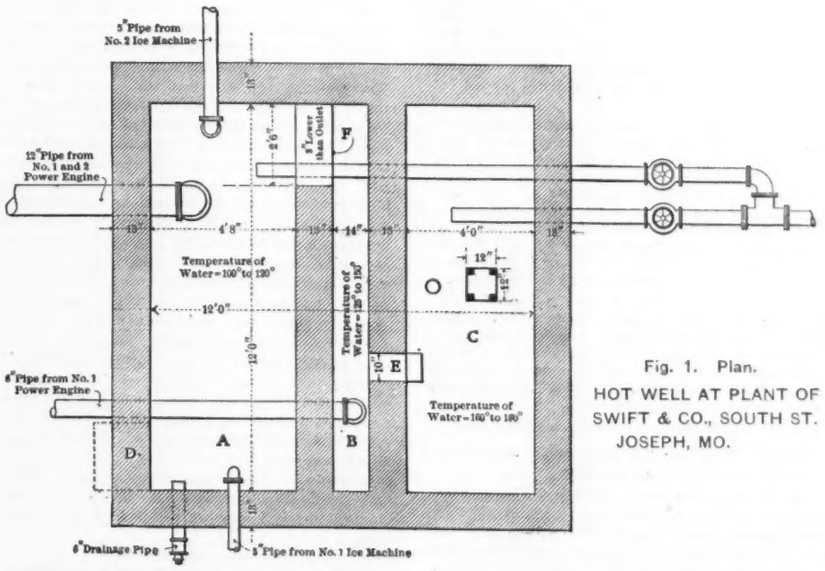

Fig. 1. Plan.

HOT WELL AT PLANT OF SWIFT & CO., SOUTH ST. JOSEPH, MO.

is kept between 125° and 160° F. to favor the boiler feed temperatures, although at the expense of the vacuum, which runs from 20 ins. to 24 ins. The higher temperature also saves condensing water. There are two outlets from B, one an underflow at E into C, and one an overflow at F into A. The overflow at F is 3 ins. lower than the one at D to insure a free passage in and out of B.

The hot side, or pump suction side C is supplied from B through E. The temperature of this water is increased by returning to it, so far as possible, all steam drips, and pump, or other exhausts, raising its temperature to from 160° to 180° F. This gives a good start for a desirable feed water temperature, and at the same time saves many traps, together with their accompanying troubles and expense, insuring the return of the various drips with their British thermal units to the boilers. The only outlet from C is through the pump suction, and only such water enters C as is sufficient to supply the pump. Should the water at any time be cut off from B, then the supply would come automatically from A through F. The hot well is provided with drain pipes in A and C for cleanout purposes.

The water enters B at a comparatively high temperature, and any oil in the water will rise rapidly to the surface, while the oil from but one condenser is all that has to be taken care of. At the same time the flow of the water from B to C is very slow, giving ample time for the oil to rise to the surface and pass off through the overflow F. Over 3,000 HP. of boilers, at one of Swift & Co.'s plant, are fed from this hot-well, and no sign of oil has been found in any of the boilers or their connections. The water from C has also been chemically analyzed a number of times, and but the slightest trace of oil has ever been found. The trace found was undoubtedly due to the oil coming in through a pump exhaust, and has in no way affected the practical working of the hot-well.

*A paper presented at the Saratoga meeting of the American Society of Mechanical Engineers, June 23-26, 1903.

†Chief Engineer, Swift & Co., South St. Joseph, Mo.

THE MERCHANTS' BRIDGE, at St. Louis, Mo., may possibly be taken possession of by the government. This bridge was built in 1889-90 to break the monopoly of the railways owning the Eads bridge. In a few years, however, this bridge was acquired by the interests owning the Eads bridge, and the Terminal R. R. Association of St. Louis now owns both bridges and several miles of railway. The old objections to the monopoly have broken out anew, and complaint has been made to the government. It is pointed out that a clause in the charter prohibits the company from consolidating with any other bridge company, and forbids any stockholder, director or manager of such other company holding a similar position in the St. Louis Merchants' Bridge Co. It further provides that in the event of violation of this clause the bridge shall become the property of the United States government and be taken possession of by the Secretary of War. The complaint as to the violation of the clause named has been made to the Secretary of War and by him referred to General Gillespie, Chief of the Engineer Corps, U. S. A. He has instructed Major F. L. Casey, U. S. Engineers, who is the officer in charge of the district, to make an investigation as to the grounds of the complaint. In the meantime, the Terminal Association is reported as seeking to acquire control of the bridge at Alton, 26 miles above St. Louis, with connecting lines, which would facilitate the handling of the through freight traffic.

GARBAGE COLLECTION AND DISPOSAL by the city is being suggested in St Louis, and complaints are made as to the inefficiency and expense of the present system, the collection especially being objected to. Under the present contract, the cost during 1902 was $89,789 for garbage removal and $127,325 for garbage reduction, making a total of $217,114. In 1901, the total was $192,900; $180,038 in 1900, and $151,192 in 1899. It has been proposed to issue bonds for the work, which will require the questions to be submitted to popular vote.

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ADVERTISING RATES: 20 *cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.*

A number of interesting questions are suggested by the recent failure of the Connecticut legislature to continue the State Sewerage Commission, and by the history of the New Jersey State Sewerage Commission. Naturally enough, the first query is, why was the Connecticut commission discontinued? This may be answered, Yankee fashion, by asking, why was such a commission created? Massachusetts had long and successfully entrusted the sanitary aspects of public water supplies and sewerage to its State Board of Health, and New York had made the approval of its State Board of Health essential to the legality of plans for sewage disposal. Later on, Ohio gave its State Board of Health jurisdiction over both water supply and sewerage, while about the same time both Connecticut and New Jersey established State Sewerage Commissions. It is only fair to the Connecticut commission to say that both its powers and funds were limited from the beginning, and that this made any extensive work on its part impossible, and therefore gave some basis for the allegation that the commission could show very little in the way of results. The obvious remedy was to increase the authority and the funds of the commission, but it was this very proposition, apparently, which caused the commission to expire with the end of its legal term of life. A bill reducing the commission from five to three men, requiring technical qualifications for all the members, and providing for a modest appropriation, passed the State Senate, but was killed in the House.

Early in the history of the Connecticut and New Jersey commissions we asked if it would not have been better, in each State, to have entrusted the work in hand to the respective State Boards of Health. We then believed that it would have been, and subsequent events seem to have justified that belief. Public opinion in Connecticut does not seem to be sufficiently advanced, and rival municipal interests, and perhaps the interests of manufacturers, appear to be too strong to make feasible thorough-going work in behalf of unpolluted inland waters. It was urged, a few years ago, that the State Boards of Health of both Connecticut and New Jersey had been so backward in their efforts to prevent water pollution, and in the study of improved means of sewage disposal, that independent commissions, entrusted with these matters, only, were essential to advance. But has not the history of each sewerage commission shown that something besides the remissness of State officials was responsible for slow progress? The authority and money granted the Connecticut commission have each been so limited that the Board of Health of that State might not have been able to accomplish any more with it than did the Sewerage Commission, but in New Jersey the statutory authority granted the Sewerage Commission was far greater, and the salaries alone paid to the members of the Sewerage Commission, if made available for engineering, chemical, and bacterial work, under the direction of the State Board of Health, would have enabled the latter body to make some important investigations. True, when the New Jersey State Sewerage Commission was established there was serious intent of making it more or less responsible for carrying out the much-needed Passaic Valley sewage disposal scheme, but that work has been taken away from the State Commission, and given to a salaried local commission. The situation in New Jersey now is: A State Board of Health of ten members (three ex officio), serving without pay. A State Sewerage Commission of five members, each receiving $1,500 a year. A Passaic Valley District Sewerage Commission of five members, each receiving $2,500 a year. The salaries of the members of the last two boards, it will be seen, aggregate $20,000 a year. Certainly New Jersey is paying heavily for work, most of which, thus far, could have been done equally well by its State Board of Health, at no expense to the State, thus making available large sums for scientific investigation. That a competent State Board of Health can do all, and more, than has yet been accomplished in New Jersey is shown by the records of the Massachusetts State Board of Health, which has not only made for itself a world-wide reputation by its investigations of water and sewage purification, but has also carried out several preliminary engineering studies of great magnitude.

Of the many ways in which water consumers use or waste more water than they pay for, lawn sprinkling is one of the most notable. Most regulations governing the use of water from unmetered services limit the use of hose for sprinkling to from two to four hours in the morning and evening, and prohibit rotary sprinklers and hose supports. The last report of Mr. F. P. Stearns, M. Am. Soc. C. E., Chief Engineer of the Metropolitan Water and Sewerage Board, contains some interesting statistics of violations of such regulations in Boston and its vicinity. The rules of the board "forbid the use of hand hose between the hours of 8 a. m. and 5 p. m., and the use of revolving or fixed sprinklers at all times unless the water is metered." Inspections made by the board between May 27 and Sept. 16, 1902, showed 1,525 violations of these regulations in the Metropolitan Water District, divided as follows: Use of rotary sprinkler, 449; fixed sprinkler, 280; hose on fixed support, 350; hose held in hand, 446. The violations per 1,000 inhabitants ranged from 0.16 in Boston to 62.81 in Nahant, but they exceeded 2 per 1,000 population in only 4 of the 13 cities and towns in the district. A far better basis of comparison than total population would be the number of hose connections on unmetered services. That the inspections were of practical value appears to be shown by the falling off in violations reported from 720 for June to 380 for July and 316 for August.

To what extent do water consumers consider such regulations reasonable? Probably most of them would acknowledge that there is justice in limiting the use of hose to a certain number of hours in the day, and doubtless the majority have no serious objection to having those hours fixed in the early morning and evening. But after granting the propriety of time limitations, and of restrictions as to the size of nozzle, it is more than likely that nine consumers out of ten feel that it should be optional with them whether during their two, three, or four hours of permissive use the hose be held in the hand, rested on a block, or attached to a rotary sprinkler. And what matters it to the water department which method is employed, so long as the time limitations are observed? Simply this: The flat rate prices for lawn sprinkling are not based on the presumptive use of water during the whole time limit, and it is well known that the water will be kept running a far shorter time, and that overrunning the time limit is much less likely, if some one must stand and hold the hose than if it may be rested on a support, or attached to a rotary sprinkler. The interests of the water department, therefore, demand that sprinklers and fixed supports for hose under flat rates be prohibited, or else that there be a special rate for them. But any one versed in the scientific use of water to supply the needs of vegetation knows that a large part of the sprinkling from hand hose is almost worthless, because few people with sizeable lawns and gardens have the patience to give grass or plants sufficient water at any one time to favor deep-root growth. A good soaking once a week, or even once in two or three weeks, is more efficacious than light sprinkling every day. Moreover, the occasional soaking may use less water than the frequent light sprinkling. If this be true, and inasmuch as it is very difficult to prevent numerous violations of sprinkling regulations, and since flat rates for sprinkling are certain to be inequitable as between the various consumers, and often result in great losses to the water department, why not hasten the day when sprinkling services will not be supplied unless the water is metered?

While newspaper editors in regions far remote from the Mississippi Valley are prone in these days to learnedly discuss the beauties of forest cultivation and reservoir construction as an antidote to floods, the people whose houses and lands are exposed to inundation by the swollen river are inclined to view the question from a more practical standpoint. St. Louis has just emerged from a severe flood and the "Globe-Democrat" says in an editorial on the levee system:

> Congress will notice that dwellers along the Mississippi River, who have had more experience with levees, and spent more upon them than has been the case in any other part of the United States, show full confidence in them as an effective method of controlling the river. Though the system now in use is incomplete and imperfect in places, it has passed through the two floods of the present year with a better record than ever. The people who see the floods come and go are absolutely satisfied that properly constructed levees give a sure protection.
>
> No vast expenditures are required, nor are any experimental schemes in engineering proposed. Operations now in progress will render the levees safer for the next flood, and the government should keep its share of the work moving steadily. States, counties, neighborhoods and individual owners are doing their part, and, in many cases, more than could be reasonably expected. Large towns, like East St. Louis, are turning to adequate levees for security. It is the duty of Congress to study the Mississippi river in its entirety and to deal with it as befits its continental importance. When the levees are as high and strong at exposed points as they should be, a flood will roll harmless to the sea.

New life has been infused into the American Water-Works Association during the past year. To begin with, the report of the last convention was published with a promptness uncommon to such organizations. This good step was followed by one even more commendable, for which some of the members and friends of the association had been hoping for years, namely, the publication of advance copies of the papers to be read at the coming convention. For a number of years it was difficult to secure copy of the program in advance of the convention. The efforts of the officials were so vigorous and the response of the members so full as to result in an embarrassment of riches; or in other words, notwithstanding the fact that the convention extended over four days, that an extra session was held, and that several

papers were read by title, only, yet the program was quite disarranged by the press of papers and discussion. This is an experience not confined to the American Water-Works Association, but which it may yet overcome by taking more care not to overcrowd its program, or by having more papers read by title. It would be well, if that is not already done, to give an opportunity to members and others to submit written discussions within say 20 to 30 days of the close of the convention. Finally, the committee on publication is to be congratulated for deciding not to print in its formal proceedings the meaningless aggregation of words, admitted with the advance papers, under the title of "Exceeding Importance of Naturally Pure Water," etc., etc. For years past the time of the conventions, and the printed proceedings of the association, have both been encumbered with mystical pseudo-scientific utterances, which the members may now hope never to hear or see again.

WHY THE NASMYTH STEAM HAMMER HAS NOT DISPLACED THE FRICTION-CLUTCH PILE DRIVER.

Some fifty years ago, when the Nasmyth steam hammer came into prominence as a pile driver, it was predicted by engineers who had seen it that the days of the rope-hoisted hammer were numbered. Nor is it uncommon to read similar predictions even to this day. That the steam hammer weighing two tons and striking 60 blows a minute is a very effective machine no one can deny, but what appears to have been overlooked by many engineers is the fact that in all driving of piles on land, a very small fraction of the working day of a pile-driving gang is spent in actual driving. This is particularly the case in building pile trestles with a railroad pile driver.

A record kept by a member of our editorial staff shows very clearly how little time is ordinarily spent in pile driving on trestle work. Each trestle bent consisted of four piles driven about 10 ft. into firm, dry earth, and bents were 15 ft. c. to c. It took about 20 blows of a 2,800-lb. hammer falling about 18 ft. to drive each pile, and, once the pile was in the leaders, these 20 blows were delivered in from 1 to 2 minutes, depending upon minor delays in keeping the pile plumb. The piles were not ringed. Hence we may say that in so far as the actual time of driving four piles was concerned, only 8 minutes were thus consumed per bent at the most. About 4 or 5 minutes were required to get each pile into the leaders, thus consuming some 20 minutes per bent.

Tabulating the time consumed in performing each detail we have:

	Minutes.
(1) Getting 4 piles into leaders	20
(2) Driving 4 piles	8
(3) Straightening and bracing the piles	27
(4) Leveling and nailing guide strips for sawing off.	10
(5) Sawing off 4 piles	12
(6) Putting on cap and drift bolting it	13
(7) Pulling 3 stringers forward from last bent	11
(8) Putting in 3 more stringers that overhang	20
(9) Putting in 1 tie and spiking rail	4
Total time on one bent	125

Item (4) was unnecessarily long, due to the hair-splitting methods of the Y-level man, who was giving the cut-off. Even after the cleats to guide the saws were nailed on, he had them lowered ⅛-in.

Items (3) and (5) may frequently be reduced very materially, and always would be on contract work, but on work done for a railroad company, as this was, time thus gained may easily be lost again through accident, carelessness or any one of a score of ways. At any rate, the end of the 10-hour day will find only 4 to 6 bents built under the conditions here given. If, however, we assume a bent of four piles built in 100 minutes, we see that only 8 minutes of that time will be consumed in actual driving. In other words, only three-quarters of an hour out of the ten was spent in hammering the pile!

This, we think, will be surprising to many of our readers and particularly to those who have been impressed by the speed of the Nasmyth steam hammers. Under a hustling, wide-awake contractor we have seen ten bents driven and completed in a day; but even under such conditions the hammer was actually at work driving less than two hours.

It seems quite clear from the foregoing that maintenance of way engineers should look not to improvements in the form of hammer mechanism, but rather to improvements in the mechanism and methods of handling the piles, caps, stringers, etc. Very much can be accomplished in this respect by having a well-organized force with a clear-headed foreman at its head. In the example just cited the item of straightening was exceedingly expensive of time, in that it consumed nearly half an hour. This was largely due to the fact that the foreman did not appreciate the importance of sawing the pile heads square. He simply put the piles into the leaders with the heads rough sawed as they came from the forest. In one case the pile had a large prong of splintered wood projecting above the partly sawed head. Haste never makes more waste than in neglecting to properly square the pile heads, and properly guide the pile while driving.

In this particular instance, since the driving was across dry land, the foreman should have secured a team with which to snake piles and timbers up alongside of or directly in front of the driver. Then the pile rope or "runner" could have been quickly hooked on to a chain already fastened around the pile or timber to be moved, with a saving of 50% in the time spent in getting material to place. Instead of spending 13 minutes getting a cap to place and drift-bolting it, not more than 6 or 7 minutes need have been so consumed. Two men can cross-cut a pile in 4 or 5 minutes, hence with eight men on four saws, item (5) can be reduced at least one-half. Running around looking for saws, mauls, drift bolts, etc., is one of the greatest causes of delay. For this reason there should be one or two men whose duty it is to bring tools and put them away immediately after they have served their purpose. The two leader men on the driver might well attend to the tools.

We could continue suggesting other details of organization that would effect further economies, but perhaps we have gone far enough if we have succeeded in showing how much may be learned as to desirable improvements, either in machinery or in management, by simply timing every item of work. We have shown by this method why the Nasmyth steam hammer has failed to displace the friction clutch hammer on trestle work, and we have shown that if any improvement is desirable in driver design it is not in the hammer mechanism, but rather in the means of mechanically handling the timbers. Finally we have shown that organization of the force is quite as essential as improvement in mechanism, while it possesses the decided advantage of costing nothing except what may be paid for a better quality of brain work.

From the foregoing discussion it should not be inferred that the steam hammer has no field of usefulness, for it has. Its field, however, is in scow or land driving, where a great number of foundation piles are to be driven close together, and especially where a great number of blows must be struck to secure the desired pile penetration.

LETTERS TO THE EDITOR.

Paved Streets of Trinidad, Cuba, with Gutters in the Center of the Street.

Sir: Under "Notes and Queries," Engineering News, June 4, 1903, reference is desired to street paving in which the center of the street is depressed and acts as a gutter.

The city of Trinidad, Cuba, is paved with small, round cobblestones, the streets varying in width from 9 meters (29.5 ft.) to 18 (28?—Ed.) meters (91.87 ft.), curb to curb.

The transverse contour is concave, consisting of two straight lines joined by an arc, the length of which raises from 1 to 2 meters and the middle depression (taken at the apex of the curve) is from 1-25 to 1-60 of the carriageway width, according to grade and character of area drained.

These pavements have been laid for more than 70 years, practically without maintenance or repairing. Traffic is light. The rainfall is from 60 to 90 ins. per annum.

Yours very truly,

G. G. Fischer.

Trinidad de Cuba, June 12, 1903.

Errors in the Carnegie and Pencoyd Hand-Books.

Sir: The standard hand-books issued by the principal iron works of this country differ in many essential respects, both as to matter and form, as is to be expected; but there are differences that ought not to be, for instance:

The least radius of gyration of a 7 × 3½ angle is given in the Carnegie hand-book as varying from 0.88 to 0.89. The Cambria hand-book gives the same quantity as varying from 0.74 to 0.76. On checking up this value I find the Cambria book to be correct and Carnegie mistaken. Likewise, the Pencoyd hand-book gives the same quantity to vary from 0.85 to 0.87, which is erroneous.

On comparing the Carnegie, Cambria and Pencoyd hand-books, there is no difficulty in detecting discrepancies of this kind. It seems that somebody is wrong, because fixed mathematical quantities are not a matter of opinion and "judgment."

E. S.

Chicago, Ill., June 24, 1903.

The Type of Steel Dam Proposed By the U. S. Irrigation Reclamation Service.

Sir: I have read with interest the letter of Mr. Chas. R. Steiner in Engineering News of June 11, submitting a general plan of a type of steel dam. Since he courts criticism of the same, I wish to make a few suggestions.

In the first place, I fail to appreciate the necessity of resorting to purely metal construction. Twentieth century work calls for steel-concrete construction wherever feasible. Mr. Steiner quite truly remarks that most sites for high dams are selected where rock foundation exists. This being true, rock is generally available for concrete-masonry and rock-fill.

Your correspondent would submit for economical construction the following design, where rock is available and the dam-site at all suitable: Make the body of the dam massive rock-fill. Secure water-tightness by means of a steel-concrete facing, anchored to the body of the dam, and uniting with the rock foundation at the inner toe and slopes. This lining should be arched in plan and laid against the rock slope previously prepared to receive it.

Where rock is not available for such construction, I favor an earth dam properly constructed and not made "just any old way."

I differ from Mr. Steiner in thinking that for very high dams, "practical and responsible constructors will think the step similar to that from a five to a twenty-story frame building.

Finally, as to design, with some modifications, I would turn his dam around, and try to avoid the Niagara effect.

Yours respectfully,

Burr Bassell, Resident Engineer, Kern River Co.

Kernville, Cal., June 17, 1903.

Approximate Formula for Mean Effective Pressure in Steam Engines.

Sir: Perhaps this belongs under "Mathematical Recreations." Some four years ago the writer made this note:

MEAN EFFECTIVE PRESSURE: In an attempt to evolve an approximate formula, without logarithms, I get this (which may not be of much use):

Given

I = initial pressure above atmosphere;
E = number of expansions;

to find

m = mean effective pressure, taking back pressure = 14.7;

$$m = \frac{(I - 3\,E)\,364}{E\,(97 - E) + 227}.$$

For any other back pressure, B, add or subtract the difference between B and 14.7.

Examples.

I.	E	Mean eff. press., lbs. From formula above	Mean eff. press., lbs. From correct formula.
80	20	4.12	4.22
160	20	20.09	20.21
80	10	16.59	16.57
160	10	43.14	43.09
80	4	41.32	41.80
160	4	89.94	89.53
80	2	64.50	65.47
160	2	134.43	133.19

The formula stuck and it has since been found of some use.

Can any of your readers simplify it, or put it into a form better adapted to combination, or for substitution, as in

$$\text{Rated power} = \frac{4\,d^2\,s\,R\,m}{1{,}000{,}000}?$$

Respectfully yours.

S.

Washington, D. C., June 10, 1903.

Concerning Concrete Mixing.

Sir: Would it not be of general interest to your patrons if those of your readers who have had the handling of large quantities of cement would write you, giving the result of their experience? I am aware that during the past few months several articles like this have appeared

in your publication, but the points that I would specially like to see covered have not been referred to.

I would suggest the following points:

(1) As to the kind and size of mixers used.

(2) As to the quantity of concrete made per unit of time.

(3) As to the quality of the concrete made.

(4) As to the detailed cost in days and dollars of making and placing concrete.

(5) As to proportions of cement, sand and stone used.

(6) Whether the mixing of the cement with the crushed stone aggregate without screening does not make a better cement than the adding of sand after passing the stone through the screens.

(7) Many engineers seem to prefer the batch mixing machine, such as the old cubical mixer. Are there any good reasons for this?

(8) What are the reasons for and against batch vs. continuous mixers?

If any one of your readers should have information about the different machines that they would prefer not to make public, I should be pleased to have them send me their comments direct. Respectfully yours,

James H. Harlow.

1402 Continental Trust Building, Baltimore, Md.
June 26, 1903.

(We have allotted a pretty fair share of our space to concrete work during the past half a dozen years; but there is still room for more contributions on the lines suggested by our correspondent.—Ed.)

Formulas for Transition Curve.

Sir: I have recently come across a very simple method for obtaining the deflections for a transition curve; the deflections being given by the following rules:

Number of subchords used = degree of main curve;

Deflection in minutes

$$= \frac{(\text{No. of subchords})^2 \ (\text{length of chord in ft.})}{10}.$$

For example, it was desired to spiralize a 4° curve using 50-ft. subchords.

$$\text{Deflection for 1st chord} = \frac{(1)^2\ 50}{10} = 05'.$$

$$\text{Deflection for 2d chord} = \frac{(2)^2\ 50}{10} = 20'.$$

$$\text{Deflection for 3d chord} = \frac{(3)^2\ 50}{10} = 45'.$$

$$\text{Deflection for 4th chord} = \frac{(4)^2\ 50}{10} = 1°\ 20'.$$

I enclose a table of deflections for 50′ subchords.

Can you inform me as to whose curve this is, and where it can be obtained with full demonstrations, showing upon what it is based? Yours truly, R. S. Webster.

Rolla, Mo., May 30, 1903.

Table of Deflections (50-ft. Subchord).

D′.	Transit at 0=PS	1.	2.	3.	4.	5.	6.
0°	0=PS	05′	20′	45′	1° 20′	2° 05′	3° 00′
1°	1 10′	20′	50′	1° 30′	2° 20′	3° 20′	
2°	2 40′ 25′	35′	1° 20′	2° 15′	3° 20′		
3°	3 1° 30′ 1° 10′ 40′	50′	1° 50′	3° 00′			
4°	4 2° 40′ 2° 15′ 1° 40′ 55′	1° 05′	2° 20′				
5°	5 4° 10′ 3° 40′ 3° 05′ 2° 10′ 1° 10′	1° 20′					
6°	6 6° 00′ 5° 25′ 4° 40′ 3° 45′ 2° 40′ 1° 25′						

[The transition curve used by our correspondent is Holbrook's Spiral, a demonstration of which will be found in our issue of June 13, 1901.—Ed]

The Comparison Between Eye-Bar Chains and Wire Cables for the Manhattan Suspension Bridge.

Sir: The principal results of a comparison between eye-bar chains and wire cables for the Manhattan bridge, prepared by Mr. Gustav Lindenthal and published in the Engineering News of June 25, are:

Eye-bar chains weigh 2½ times more than wire cables. The total dead load of a chain bridge is 8½% more, and its total cost $142,000 less than that of a wire cable bridge.

About three months ago the writer made an investigation of the same subject, published in the Engineering News of March 12, 1903, with the following results: Eye-bar chains are 5¼ times heavier than wire cables. The total dead load of a chain bridge is 55% more and its total cost $3,360,000 more than that of a wire cable bridge.

The writer revised these calculations recently, in accordance with the probable qualities of nickel steel for the eye-bars, and with the actual qualities of steel wire. The results are: Eye-bar chains, in order to sustain the same loads with the same factor of safety, must be 7½ times heavier than wire cables, and the total dead load of a chain bridge must be 82% greater than that of a wire cable bridge. The total cost of a chain bridge is $5,280,000 more than the cost of a wire cable bridge.

These results differ so widely from the figures given by Mr. Lindenthal that, necessarily, either his or the writer's comparison must be wrong.

It is easy to demonstrate that Mr. Lindenthal's statements are wrong in almost every particular point:

(1) It was "assumed" that nickel steel, as proposed for the eye-bars, had an ultimate strength of 85,000 lbs., and an elastic limit of 48,000 lbs. per sq. in.

According to experiments, which were made by the American Bridge Co. for manufacturing nickel steel at a reasonable price, the best average qualities were found to be 75,000 lbs. per sq. in. for the tenacity and 45,000 lbs. per sq. in for the yield point. The "assumed" quality of nickel steel is also in contradiction to Mr. Lindenthal's testimony before the Finance Committee of the New York Board of Aldermen. He testified that the eye-bar steel would practically be of the same quality as the steel in the superstructure of the Williamsburgh bridge. This steel has still lower qualities than stated above.

(2) It was further "assumed" that cable wire, No. 7 gage, would have a tenacity of 190,000 lbs. and an elastic limit of 150,000 lbs. per sq. in. The quality of steel wire has passed the state of "assumption." It is accurately known and should be known by anyone who attempts to make comparisons. The tenacity of No. 6 wire, as used in the cables of the Williamsburgh bridge, is actually 223,860 lbs., with an elastic limit of 190,000 lbs. per sq. in. This is the average from 16,500 tests, added up by the writer himself. The tenacity of No. 7 wire is at least 235,000 lbs.

(3) It is stated that the safety of a structure is, universally, expressed in terms of the breaking strength of the material. This was true about 25 years ago, when the safety factor for bridges was 1/5 or 1/6 of the breaking strength; but since engineers have learned the value of a high elastic limit, they have dared to reduce the safety factor to ½ of the breaking strength, and many engineers gage the safety entirely by the relation of the working stress to the elastic limit. If the elastic limit were no factor in the safety of the bridge, it would not be necessary to speak of it, but all engineers do so, and Mr. Lindenthal himself contradicted his first statement, immediately after he made it, by saying that the working stress should be "well within the elastic limit," or, in other words, be a fraction of the elastic limit. This statement is again contradicted, later on, by Mr. Lindenthal's novel argument that a strain beyond the elastic limit would rather be an advantage, inasmuch as such a stress would increase the elastic limit as well as the breaking strength. How many engineers are willing to "improve" the material in their bridges by straining it, occasionally, up to 70,000 lbs. per sq. in. when its ultimate strength is but 85,000 lbs.? Not one.

That the higher tenacity of wire is obtained by precisely the same process, is entirely wrong. While the material in a bridge is simply pulled or compressed, wire, when it is "drawn," is at the same time squeezed, and it is the latter process that enhances the strength of wire. The pulling alone would not do much good.

Considering that all calculations of stresses are correct only within the limit of elasticity, and that loading a bridge up or near to the rupture point never occurs, it stands to reason that the limit of elasticity is a more correct measure for gaging the safety of a bridge than the breaking strength of the material.

For these reasons the writer considered the average between the respective limits of elasticity and the strength of two materials to be the correct proportion between the construction strength of said materials.

Therefore:

$$\frac{190{,}000 = \text{elastic limit of wire}}{45{,}000 = \text{elastic limit of nickel-steel}} = 4.22$$

$$\frac{223{,}860 = \text{ultimate strength of wire}}{75{,}000 = \text{ult. strength of nickel-steel}} = 2.98$$

$$\text{Average} = 3.6$$

Hence

$$\frac{\text{Construction strength of wire}}{\text{Construction strength of nickel-steel}} = \frac{3.6}{1}.$$

In Mr. Lindenthal's comparison this proportion was wrongly assumed to be $\frac{2.1}{1}$.

(4) It is stated that the weight of the stiffening construction in the chain bridge is 5,250 lbs. per lin. ft., and 8,135 lbs. in the wire cable bridge. While it is true that the heavier chain bridge will require less stiffening than the lighter cable bridge, it can be shown that the inherent stiffness of a wire cable, compared with a perfectly flexible chain, does more than offset the advantage of weight. However, not counting on the stiffness of the cables, it is certainly wrong that for a difference of 15% in the weight of two bridges, the weight of the stiffening construction in the lighter bridge should be 55% more that that of the heavier bridge! The weight of the stiffening trusses of the Williamsburg bridge is 3,800 lbs. per lin. ft., and some of the five examining experts have, at previous occasions, declared that these trusses are much too heavy, and that the Williamsburg bridge is stiffer than necessary. Compare, therewith, the immense weight of 8,135 lbs., or only of 5,250, as proposed for the Manhattan bridge, engineers must at once see the extragavant and uneconomical construction in the design of that bridge!

(5) It is "believed" that eye-bar chains can be completed at 6½ cts. per lb.! The price should not be a matter of "belief," but one of certainty, and certainty can not be obtained without precedents. The only precedent of recent date is furnished by the new Buda Pest bridge, where the actual cost of the chain in place was 8¾ cts. per lb. for ordinary structural steel. As in Germany and Austria prices of steel and labor are lower than in America, it is not probable that chains of nickel-steel, which alone adds 1¾ cts. to the price of ordinary steel, to be erected over the East River on expensive temporary suspension bridges, will cost less than they have cost at Buda Pest. A price of 9 cts., as assumed by the writer's calculations, is much more probable than 6½ cts.

The price of the wire cables at the Williamsburg bridge, not including the suspenders, was 14 cts. per lb. Making the corrections, as explained above, and always keeping in view that the Manhattan bridge should have the same strength as the Williamsburg bridge, it will be found that the writer's calculations are correct.

Of other arguments, advanced by Mr. Lindenthal, the saving of time, as is claimed for the construction of eye-bar chains, is the most important. This argument, however, is based entirely on guesswork, and, therefore, of no value at all. On the other hand, the writer has a right to assert that wire cables, as proved by experience, can be erected in six months.

The writer does not claim that an eye-bar chain bridge is not practical from an engineering point of view, but he does claim that it is very uneconomical from a financial standpoint. By making arbitrary, unwarranted assumptions, and by subjecting the material to higher stresses than other engineers would consider safe (39,000 lbs. per sq. in. for an elastic limit of 48,000 lbs.), it is, of course, possible to reduce or even to reverse the figures made by the writer; but, on the basis of facts, those figures prove conclusively that either the Manhattan bridge will be a much weaker structure than the Williamsburg bridge, or that it will cost some five millions of dollars more than it ought to cost, if constructed with wire cables! Will the board of experts pass a design which gives to the City of New York a weak, if not absolutely dangerous new bridge, or will they help in burdening the taxpayers with an unnecessary debt of five millions of dollars?

Wilhelm Hildenbrand.

New York, June 30, 1903.

Wire Cables or Eye-Bar Cables for the Manhattan Bridge.

Sir: On page 557 of your issue of June 25, among your "Notes of Interest to Engineers" you give the names of engineers who appeared by invitation before the Committee of Finance of the Board of Aldermen, Manhattan, to give their views upon the proposition to issue at the present time $6,500,000 bonds for the construction of the Manhattan Bridge No. 3 across the East River.

You fail to state, however, what important facts these engineers had to present in this matter, but on the other hand, print on page 576 a hypothetical estimate of cost of this proposed bridge, based on the "Lindenthal Design," in comparison with an exaggerated cost of an identical bridge in which wire cables replace the proposed eye-bars. These comparative estimates are furnished you by the Commissioner of Bridges, who is himself an eminent engineer of repute and who has built a number of bridges of special design, each different from anything previously constructed in this country.

It is apparently the object of this engineer to again build a bridge of a new type and design, with which he has had no previous experience, and he has suggested a structure the like of which both in material, detail and dimensions has never been attempted.

It would be unnecessary to go into the history of this bridge at the present time were it not that the Commissioner is attempting to saddle this experiment upon the city under the claim that its rapid and immediate construction is imperative. It should be remembered that detailed plans for an equally good structure, prepared by an equally eminent engineer, were on hand in the Department of Bridges eighteen months ago and are still in existence. These plans were rejected by the present Bridge Commissioner; the engineer who prepared them was forced out of the department, and the design of a new bridge was begun. This proceeding has already caused a delay of 18 months.

Now let us examine the comparative estimates of cost of this bridge on page 576, as furnished you by the Commissioner, and see how they appear under the glare of a searchlight in the hands of a taxpayer and an engineer who has been engaged for many years on the design, fabrication and erection of suspension bridges of the largest class, both as assistant and expert adviser to the present Commissioner of Bridges and other eminent engineers, and who at the same time, above all else, has made a deep and exact study of the qualities of materials, their processes of manufacture, and of their fabrication, and finally the testing of the materials of finished parts.

No one acquainted with the writer would dare say that he is not thoroughly familiar with every method of bridge

fabrication and with all of the largest bridge shops in this country and many of those abroad.

The writer challenges any engineer to prove that the statements and figures given below are not in accord with absolute fact.

In this comparative estimate the Commissioner defines the supposed qualities of wire that is at the present day used in wire cables, and of the steel which he proposes to use in eye-bars of his chain suspension bridge. Both of his specifications are inaccurate. The wire readily obtainable from several works and in use at the present time has a yield point of 185,000 lbs. and a tenacity of 225,000 lbs. and not 150,000 lbs. and 190,000 lbs., as given. The above figures were obtained, some by myself, from actual finished wire.* The nickel steel bars of the quality proposed are supposed to show a yield point of 48,000 lbs. and a tenacity of 85,000 lbs. These values, however, can only be based on small test sample bars and have not been obtained from finished 18-in. eye-bars, because such bars have never yet been made. Now this relation of yield point to tenacity when determined in the same manner as was done when obtaining them for wire are incorrect. Nickel steel of 85,000 lbs. tenacity when correctly tested by a reliable man and machine will show a yield point of at least 58 to 60,000 lbs., and not 48,000 lbs., in small test bars. What it will be in 18-in. eye-bars we have no means of determining; they have never been made and tested. But we do know that when full-size eye-bars of 70,000-lb. steel were tested and the observed result of load at instant of rupture was corrected for friction of testing machine (knowing that the gages were correct), the actual tenacity was found to be not 70,000 lbs., but 54,600 lbs. Moreover, these bars were small when compared with those proposed to be used; and it is the rule that the loss of strength of large bars as compared with sample bars increases with the cross section of the bars.

Another fact not to be forgotten is this: That there is no testing machine in the world of even one-half the necessary capacity to test these eye-bars. None has even as yet been conceived of sufficient magnitude to determine the strength of these gigantic bars.

Another fact of importance is this: Every wire in the suspension bridge cables is tested twice; once at each end. For every 140 lbs. of wire in its finished state one test is made. Therefore we know the strength of every cable with absolute scientific accuracy.

If, on the other hand, eye-bars are used and we assume that but one out of every 25 be tested, the expense of such tests will be more than 7% of the cost of the eye-bar chain. If reliance be placed on tests of sample bars and one test be made of the steel for each bar, even in this case there will be but one test for every 5,000 lbs. of material or more. The cost of these sample tests will amount to at least $10,000, and for this expenditure we would know absolutely nothing of the real strength of the *eye-bars*. The total cost of testing every wire in the cables twice will not reach $5,000, and then we shall know the strength of the cables with absolute accuracy. There has never yet been devised a method for determining internal defects and for testing the safety and strength of the pins which it is proposed to be used in coupling the *eye-bars* together to form these *chains*. It is a pure assumption that the chains will be as strong as the assumed —but unknown—strength of the eye-bars.

The wire can be made by a number of makers, several of which have declared their willingness to bid for the making of the cables. There is not now in existence in the world any machinery adapted for making eye-bars of the dimensions given, and when these bars are completed this machinery will be of little further use and value, and its cost must be charged up in full to the cost of making these eye-bars, as such may never again be made for any purpose whatsoever.

The machinery used for making wire is now in every-day use and its repairs and maintenance only will be charged to the cost of making wire cables. Wire for cables has been and can be furnished within three months from the letting of the contract. Nobody knows how long it will take to make 18-in. eye-bars. Only after letting the contract can the successful bidder begin the planning of his shops for making these eye-bars and the building of the necessary equipment cannot be completed within 18 months, in accordance with all previous experience. All the necessary wire can be made in three months.

Nobody knows how long it will take to make such gigantic eye-bars; it has never been done. It will take more than eighteen months to build a sufficient testing machine and to calibrate it to prove the quality and strength of the eye-bars; without such tests it would be dangerous to build a bridge with such eye-bars. There is not now in existence any apparatus by which the testing machine can be calibrated. And after the completion of these eye-bars there would no longer be any real use for this testing machine, and its entire cost, or at least 50% thereof, and of the cost of its calibration would have to be charged to the cost of the eye-bars.

From the actual experience and record made on the Williamsburg bridge we know that it will take but six months to make the cables for Bridge No. 3; while no one in the world knows or can guess how long it will take to erect these gigantic chains. In the first place, footbridges necessary in erecting cables and chains must be constructed. For the wire cables these will cost not over $90,000 and can be built in three months; for the chains they must be necessarily five times as strong, as they must carry more than five times the load; they will cost at least $500,000 to build and remove and it will take at least nine months to build them.

It is necessary here to call attention to a serious point in coupling up the pins and bars after the first set has been coupled up and swung, which will cause delay in erecting the chains. The latter and the pins are of such gigantic proportions and change shape to such an extent by initial loads that it will require machinery and hydraulic presses to force the bars on the pins, everything being supported by the footbridges. How much time and money it will cost to do this is known only to the Allwise, and that this method is inevitable is proven by the massive proportions and weights of all of the material to be handled.

Let me ask another question affecting the construction of cables and chains. How long will it take to replace one of the eye-bars or pins of the chain should it fall overboard into the river with its great depth and swift current? It could not be found by a diver, and only the good Lord could tell how long it would take the steel works, rolling mill, forging plant and testing laboratory to produce a satisfactory substitute, while the bridge is waiting. Did I say testing laboratory? Why certainly not; who would think of testing a bridge member made under the highest pressure and excitement with gangs of men waiting for it, the completion of the bridge delayed just so much and millions of dollars drawing interest every day of delay this accident would cause. Only one bar would be made and could not be tested. Hence this new bar would be made under the most unfavorable conditions of extreme hurry and worry only to minimize delay; and what if it should happen to be defective? In it would go, no matter how little we know of its qualities or perfection. "Damn the testing! we can't wait," the contractor says, "the people are howling for the bridge to be opened and a heavy fine stares me in the face for failure to complete the bridge in time." That's where the shoe pinches! Has anyone ever heard of first-class work being done under such conditions?

And what would happen should a wire or even a whole strand of wires (360 of them) fall into the river? Nothing whatever! The wires would simply be cut and dropped into the river to be fished up at a convenient time, but the work would only be delayed a few hours until another wire or strand were coupled up and started across the river.

Now about the prices of the materials! It is a well-known fact that the wire the writer specified above can be bought in the open market; but the figure of 15 cents per ft., given in the report, is incorrect. It is exaggerated, because the finished cables on the Williamsburg bridge did not cost as much as that. They actually cost less! Now what will the price of eye-bars be? The Commissioner tells us 6½ cents per lb. of eye-bar chain. This is based on the usual cost of bottom chords of truss bridges composed of bars and pins which are mere toys alongside of the gigantic pieces proposed to be used in these chains! Prices given to me within a year by two of the largest steel works in the country for nickel steel not much better than this material proposed to be used, were vastly higher than the price here stated, and I am prepared to assert without fear of contradiction "that the rough forged material will cost more than 6½ cents per lb," to say nothing about the necessary footbridges and erection. It is a known fact that the necessary footbridges will cost not less than one-half million dollars, or, on the basis of the Commissioner's weights, no less than 1¼ cents per lb. of chain.

It is another known fact that the cost of erection and painting of such an aerial structure will cost not less than 1¼ cents per lb. or $500,000. Hence it must be possible to obtain 2½% nickel steel forged and finished as eye-bars for 4 cents per lb.

Is there any engineer who knows what nickel steel costs so blind and unknowing as to believe that this material can be bought for such a ridiculously low price?

Now let us see what these differences in quality of material and their prices means and will make in dollars and cents. As we know the actual strength of each wire and of each cable in its finished condition, and have a right to assume that there is absolutely no possibility of overloading or concentrating loads to an excessive degree at any point in either bridge, we are justified in using the highest possible unit stress of load on the wires, say 61,666 lbs. per sq. in. = ⅓ yield point. On the other hand, we know nothing about the absolute strength of a chain, and we shall certainly know but very little of but a few pieces of bars and eyes—which do not go into the bridge at all—but merely assume that all the others actually used in the bridge are equally good (without any proof or knowledge of this fact), and then load these eye-bars in the invariable manner customary in all pin connected bridges heretofore built, with a load equal to ½ the yield point or 24,000 lbs. per sq. in. we shall find, using the Commissioner's figures of loading (14), that the wire cables will weigh with a cross-section of 927 sq. ins., only about 10,428,750 lbs.; while the chains with a necessary cross-section of 2,760 sq. ins., will weigh about 49,956,000 lbs. total. Now the fact is that cables have cost less than 14 cts. per lb., and may cost much less; but at that figure these wire cables would cost only $1,456,000; while the chains, at the Commissioner's absurdly low price of 6½ cts., would cost not less than $3,067,100. However, it will be found that the minimum price for these nickel steel chains erected will be 10 cts. per lb. and actual cost will be $4,956,000 or $3,500,000 more than we *know* that wire cables actually have been built for.

On the above basis of weight of chains and cables items 21 to 23 will be about as follows:

		For Chains.	For Cables.
21	About	.....	$350,000
22	"	$27,900	.....
23	"	105,000	.....
	Now to summarize we shall have		
19	Cost of cables at 14 cts.	.....	$1,456,000
20	Cost of chains at 10 cts.	4,956,000	.....
21	Additional steel in stiffeners at 5 cts	.....	350,000
22	Additional steel in towers at 7 cts.	27,900	.....
23	Additional cost of anchorages at $7.05	105,000	.....
24	Totals	5,088,900	1,806,000
25	Difference	.....	$3,282,900
	Or on the Commissioners' prices:		
19	Cost of cables at 15 cts.	.....	1,564,300
20	Cost of chains at 6½ cts.	3,247,100	.....
21	Additional steel in stiffeners at 5 cts	.....	350,000
22	Additional steel in towers at 7 cts.	27,900	.....
23	Additional cost of anchorages at $7.	105,000	.....
24	Totals	$3,380,000	$1,914,300
25	Difference	.....	$1,465,700

Now, as a matter of fact, if we test both ends of each piece of material in a structure and determine its three essential characteristics: "yield point, tenacity and elongation," and are positive about impossibility of local overloading, it is not only permissible, but also eminently proper to the interest of economy and rapidity of construction (especially as we know that cables can be prevented from corrosion absolutely, which is not the case with pin-connected chains, and also that if through carelessness, corrosion does occur in the wires, they can be removed and replaced by sound ones, making the cable as good as new) to load wire as a maximum up to half of its yield point, especially as this is the limit never exceeded and hardly ever even reached or allowed in built-up structures.

With such permissible unit stresses it will be seen that a wire cable bridge would cost more than $1,000,000 less than above figured or about $4,282,900 less than a similar bridge in which eye-bar nickel steel chains are used, all other details being equal.

It is certainly of the greatest importance that this bridge be built without further delay, but I, as a taxpayer object to be assessed unnecessarily for my share of over $4,000,000 solely that our Commissioner of Bridges may make another experiment in bridge building and build himself a monument which will be an everlasting eyesore to the community because of its top-heavy appearance.

Gus. C. Henning.

275 Water St., New York City, June 28, 1903.

*The records in the Department of Bridges of more than 10,000 tests show an average result of more than 185,000 lbs. yield point and more than 225,000 lbs. tenacity.

Notes and Queries.

The article on "Comparisons of Eye-Bar Chains with Steel-Wire Cables for the Manhattan Bridge," published on p. 576 of our issue of June 25, contained a typographical error due to the blurring of a figure in the typewritten "copy." The total weight of the eye-bar chains should have been given as 29,040,000 instead of 39,040,000 lbs.

ANNUAL MEETING OF THE AMERICAN WATER-WORKS ASSOCIATION.

The twenty-third annual convention was held at Detroit, Mich., June 23 to 26, with some 500 members and guests in attendance. A hearty address of welcome was made by Mr. W. C. Mabury, Mayor of Detroit, and was suitably acknowledged by Mr. L. N. Case (Duluth, Minn.) and Mr. E. W. Pendleton (Detroit). The presidential address was then delivered by Mr. C. H. Campbell (Charlotte, N. C.), President Campbell called for closer relations of the water-works men with the fire departments on the one hand and the insurance bureaus on the other. To this end he recommended the formation of state organizations, which should serve more local interests than the national association, but might yet be affiliated with it and work with it toward ideal conditions; as a first move he suggested appointing a committee on insurance. The president's recommendations were later referred to the executive committee for immediate consideration. The secretary then read applications for membership from over

70 persons, one living as far away as Cape Town; on motion all the applicants were elected to membership in the grade applied for.

The annual report of the executive committee recommended, among other things, that such technical papers as print accounts of the proceedings of the association, or reprint papers presented before it, be allowed one representative in the grade of active member, without dues, and be given one page of advertising in the "Proceedings," without charge. The report was accepted and its recommendations adopted by the meeting. The secretary and treasurer reported a membership of about 400; assets totaling about $3,000; and yearly receipts and disbursements in the neighborhood of $2,500 and $1,500, respectively. The Committee on Permanent Headquarters asked for its discharge, saying that there was no present or prospective need for permanent headquarters. This statement met with evident general approval and the committee was discharged. Next, the Committee on Electrolysis reported; it briefly reaffirmed the action of the 1901 meeting in adopting resolutions calling for an insulated, metallic return on all electric trolley roads. The report was adopted without discussion and the committee continued.

The session of Tuesday afternoon began with a paper by Mr. S. E. Babcock on "The Supply for which a Water-Works Should be Proportioned." The discussion on this was quite prolonged, and left room only for the reading of a paper by Mr. H. O. Nourse, of Chicago, Ill., on "Water Rates." The evening of Tuesday was devoted to a social eating and drinking, quite elaborate, with a vaudeville entertainment, in the large hall of the Hotel Cadillac.

On the following morning a committee appointed to consider the recommendations of the president reported. It recommended that a conference committee be appointed to act with the New England and the Central States Water-Works Associations and with the fire-insurance bureaus, in bringing together water-works men and insurance men. On the subject of state organizations the committee held that local interests must lead to their formation, and that the American Water-Works Association could not deal with the matter at present. Following this, discussion was opened on Mr. Nourse's paper of the previous day; it finally led to the appointment of a committee to consider water rates, and if possible settle on a practicable basis of charging. Another committee was appointed to take up the matter of Form of Accounts. The Committee on Cast-Iron Pipe, whose report followed, reviewed the action of the New England Water-Works Association on the same subject, and recommended the adoption of their standard specifications. Such action was strongly opposed by Mr. Geo. H. Benzenberg, and the meeting then decided to continue the committee, with Mr. Benzenberg as added member, to further consider the subject.

The annual election of officers resulted as follows: President, Mr. L. N. Case, Duluth, Minn.; Vice-Presidents, Messrs. M. R. Sherrerd, Newark, N. J.; T. H. Bennett, Oswego, N. Y.; C. E. Rowe, Dayton, O.; B. C. Adkins, St. Louis, Mo., and A. A. Tucker, Memphis, Tenn ; Secretary and Treasurer, Mr. J. M. Diven, Elmira, N. Y. (re-elected).

A steamer trip down the river to Lake Erie was the much enjoyed entertainment of Wednesday afternoon. During the trip the fireboats of Detroit were exhibited in action, through the courtesy of the Detroit Fire Commissioners.

Wednesday evening was a show session. Ladies were invited, and three lantern slide lectures were presented. Prof. W. P. Mason (Troy, N. Y.), related what he had seen in the way of special or unusual features in a number of European water supply systems. The new large mechanical filter plant at Little Falls, N. J., was illustrated and succinctly described by Mr. G. W. Fuller (New York, N. Y.) Lastly, Mr. A. A. Knudson (New York, N. Y.), reported his more recent experiences in electrolytic corrosion of underground pipes.

Thursday was to have had only two sessions, but so little work had been accomplished in the five sessions held up to Thursday noon, that it was decided to devote the evening to an extra session. At the beginning of the morning session a lively discussion grew out of the question where to hold the next convention. St. Louis, which had been strongly boomed by a special "Louisiana Purchase," delegation, headed by Mr. B. C. Adkins, was as strongly opposed by others, on the ground that attempting to combine the serious work of the meeting with sightseeing at the Exposition would be detrimental to both purposes, or that at any rate the technical proceedings would be robbed of all value. Numbers prevailed, however (the supply men having the right to vote on this question) and St. Louis got the convention over Kansas City. It may be said here that the executive committee later fixed the time for the convention as either the week of June 6, 1904, or the week of June 13, leaving the final choice to the local committee. This matter disposed of, a paper by Mr. D. H. Maury (Peoria, Ill.) was read and fully discussed.

The afternoon session of Thursday was opened by Mr. F. A. W. Davis (Indianapolis, Ind.), with a paper entitled "Shall Inside Fire Lines be Metered, and Shall There be a Charge for the Service." Representatives of fire insurance companies had been invited to this session, and an interesting discussion of the matter of private fire-lines followed Mr. Davis' paper. The session closed with the announcement of the following committees for the coming year: Water Rates, Messrs. H. E. Keeler (Chicago, Ill.), Geo. H. Benzenberg (Milwaukee, Wis.), and F. C. Kimball (Knoxville, Tenn.); Publication, Messrs. H. E. Keeler, M. R. Sherrerd (Newark, N. J.), D. W. Mead (Chicago, Ill.), D. H. Maury (Peoria, Ill.), and J. M. Diven, (Elmira, N. Y.); Uniform Classification of Accounts, Messrs. D. R. Gwinn (Terre Haute, Ind.), and J. Caulfield (St. Paul, Minn.); Specifications for Cast-Iron Pipe, Messrs. J. J. R. Croes (New York, N. Y.), G. H. Benzenberg (Milwaukee, Wis.), and S. E. Babcock (Utica, N. Y.); Fire Insurance Rates, Messrs. C. H. Campbell (Charlotte, N. C.), G. H. Felix (Reading, Pa.), R. G. Boardman (Brevard, N. C.), F. A. W. Davis (Indianapolis, Ind.), and R. J. Thomas (Lowell, Mass.).

The Thursday evening session was opened by Mr. D. R. Gwinn (Terre Haute, Ind.), with a paper on "Plumbers and Plumbing." After some discussion on this, Prof. E. G. Smith (Beloit, Wis.), spoke on "Some Recent Experiences with Growths in Mains," reporting several recent cases of trouble from Crenothrix in the Middle West. In discussing this paper, several members reported other similar cases of trouble which may be due to the same iron-eating microbe. Mr. J. W. Alvord (Chicago, Ill.), presented a paper entitled "Depreciation," which analyzed the losses in value occurring in water-works systems. The discussion of this paper extended until adjournment for the evening.

The concluding session of the meeting was held on Friday morning. Papers were read on "Free Water Furnished to the City of Richmond, Ind.," Mr. H. E. Dill (Richmond, Ind.); "Meter Location and Meter Accounts," S. A. Charles (Lexington, Ky.); "A Simple Device for Testing Fire Hydrants for Freezing," Mr. E. L. Nuebling (Reading, Pa.); "Our Annual Meetings," Mr. S. J. Rosamond (Ft. Smith, Ark.).

After the discussion of these papers, several others were read by title, as follows: "Thickness of Cast-Iron Water Pipe," Mr. J. T. Fanning (Minneapolis, Minn.); "The Necessity of a Systematic Inspection of all Water Services and Fixtures," Mr. H. C. Hodgkins (Syracuse, N. Y.); "Water Waste and its Prevention," Mr. W. S. Crandall (New York, N. Y.); "Fire Protection Water-Works," Mr. N. P. Simin (Moscow, Russia); and "Preliminary Steps to be Taken in Water Supply Investigations," Mr. L. J. Le Conte (Oakland, Cal.). Among the papers printed in advance was one by Mr. C. Monjeau (Middletown, O.), on "The Exceeding Importance of Naturally Pure Water; Its Indispensableness to Health in Man and Beast, as shown by Seventeen Years of Experimental Study." On recommendation of the publication committee, however, this paper was not read and will not appear in the "Proceedings" of the Association. The "Question Box" was then taken up, and the half-dozen questions it contained were briefly discussed. As a concluding ceremony the retiring president installed his successor, Mr. L. N. Case, in office, and the Association then adjourned.

Entertainment was provided for Friday afternoon in the shape of a trolley-car and carriage drive to Grosse Pointe Park on Lake St. Clair, the Detroit Water-Works pumping station, and Belle Isle Park, a magnificent city park, comprising the whole of an island of 700 acres at the outlet of Lake St. Clair. It should be mentioned that in the course of the meeting the association presented a silver service to the chairman of the local committee in recognition of the welcome and entertainment accorded it during the meeting.

The main portion of the professional proceedings are abstracted in the following:

REQUIRED CAPACITY OF WATER-WORKS.

The paper of Mr. S. E. Babcock (Utica, N. Y.) on "The Supply for Which a Water-Works Should Be Proportioned," reiterated and supported by tables the known fact that the maximum demand on water-supply systems is greater than the average demand, and that the former must determine the capacity to be provided. Monthly, weekly, and daily variations occur, and the maximum day's consumption may reach 300% of the average for the year. To get at the required average per year, it must be remembered that different classes of consumers use different average amounts. Mr. Babcock's recommendations are, substantially:

Subdivide the district into (1) Dwelling house and (2) Tenement house population, (3) Manufacturing, estimated in equivalent or tributary population, (4) Mercantile, also estimated in equivalent population. Then assume average annual consumption (1) for dwelling houses sanitarily equipped and used, 60 to 70 gallons per capita per day; (2) for tenement house uses 15 to 35 gallons per capita per day; (3) for manufacturing uses, 10 to 30 gallons per day, per capita of equivalent or tributary population; (4) for mercantile uses, 5 to 15 gallons per day, per capita of tributary population. Add to this 3 to 9 gallons per capita of the whole population, to allow for public uses; and to cover unknown wastage add 15 to 45 gallons per capita. The aggregate amount so found must be multiplied by 300 to 400 per cent. to give the maximum demand with provision for probable growth and a safe reserve.

The matter of unknown waste was emphasized by the author. Some tables showed that in the few fully metered (or nearly so) towns in this country the meter aggregate represents only half or less of the pumpage.

In discussion, Mr. D. W. Mead presented a mass of evidence on monthly, weekly, daily, and hourly variation of water consumption, obtained from records taken in a number of towns in Illinois and Indiana. This matter was corroborative, in general, of the opinion of Mr. Babcock that a maximum daily demand in excess of 200% of the yearly average must be allowed for. This is particularly important in the design of filter plants with little storage capacity, where the supply from the filters must follow the demand even in its hourly variations. In one case investigated by Mr. Mead the maximum hourly consumption was 235% of the average for the year.

WATER UNACCOUNTED FOR OR WASTED.

A question as to whether allowance for slip in pumps had been made in the Massachusetts Board of Health figures of pumpage precipitated an animated discussion on sources of real or apparent loss in water supply systems. A few of the points which developed are given here.

In Lorain, O., all pipe has been laid by the city for some time past, and on testing such pipe under pressure there is no leakage whatever. On the other hand, when pipe is uncovered which was laid by contractors, nearly every joint is found to be leaky. In that city meters are being extended to all services as rapidly as possible, and it is considered that more waste is prevalent in this way than a large corps of inspectors could suppress.

The case of Yonkers, N. Y., which is all metered but yet can account for less than half the pumpage, was repeatedly cited. It was suggested that there must be great slip and leakage in the pumps used there, or leaky mains, or very poor meters. Mr. E. L. Peene (Yonkers, N. Y.) explained, however, that part of the discrepancy is to be charged to a new (leaky?) distributing reservoir, and another part to the poor condition of the pumps,

which can not be stopped for repairs. From an apparent pumpage of 33,000,000 gallons into the reservoir referred to, only 21,000,000 gallons flowed out of the reservoir, the difference being due to pump "slip" and loss in the reservoir. A large loss is also caused by great waste of water by the city. The sewer system of Yonkers is much too small for the town, which has grown rapidly, and frequent heavy flushing is resorted to.

The question of pump "slip" received much attention as a probable source of difference between real and apparent pumpage. Several cases of very bad "slip" due to piston leakage in inside-packed pumps (with brass ring packing) were cited. The suggestion was made to put a Venturi meter in the pump delivery pipe to measure actual pumpage. Some doubt was expressed whether such a meter would register accurately with the large pulsation due to the pump strokes. In answer, the case of a new pump in Detroit was cited, which is to have a 42-in. Venturi meter in the discharge; the pumpmaker has guaranteed a pressure variation under 5%, and the maker of the meter guarantees the meter to record accurately with such a variation. Actual tests are yet wanting on this installation.

Water waste, either wilful or accidental, was a most absorbing subject to the water-works men, and it came up again and again in the discussion of various papers, after being introduced at the very first session in the discussion on Mr. Babcock's paper. All manners of waste were talked about, leaking mains, broken mains or service pipes, leaky fixtures, lawn and street sprinkling, stealing of water, etc., etc. Mr. J. W. Alvord (Chicago, Ill.) cited the case of a village buying water from another, and distributing it by about 15 miles of mains. There was no free service on the system, yet after a year's operation a full third of the water paid for by the village (according to meter in its supply pipe) did not go through the service meters. Assuming all the lost water to have leaked out of the joints in the mains, it would represent only a few drops per hour per joint. Mr. J. V. Clark (Washington, Pa.) said that with all his services metered the total pumpage was 1,200,000 gallons, while only 584,000 was paid for according to the meters. At Columbus, O., pump slip and waste at fixtures combined to make a high consumption, which by repacking the pumps and increasing the number of meters from 33% to 70% of all taps was decreased by one-half. In the same city a 4-in. main was found badly pitted and leaking, and it was discovered that the electric light company had grounded one of its street lighting wires on the pipe. At Evansville, Ind., refitting the pumps cut down the water pumped from 200 gallons per capita per day to 107 gallons.

Flush tanks are a frightful cause of waste. Mr. S. J. Rosamond (Fort Smith, Ark.) had one-third of the water pumped running through flush tanks. The waste was reduced by fitting the flush tanks with special nozzles which contained a steel disk having a 1-16-in. hole. The total consumption has been cut down to 100 gallons per capita. Mr. D. H. Maury (Peoria, Ill.) told of a case where out of 500 flush tanks only one was working, but that one flushed 25 times a day, where it should have flushed only once. The others were not flushing, but the water simply ran through the tanks and wasted. The waste was done away with by fitting proper nozzles. A great waste also took place in range-closets in schools, where automatic flush tanks were used. In spite of enormous waste of water the sanitary condition of these closets was horrible. Automatic flush tanks of this kind were abolished with the help of the city authorities; a further reduction of waste resulted from an investigation of lawn-sprinkling on boulevards. Fire consumption was by some credited with leading to great waste. Mr. C. W. Hubbell stated that in Detroit the fire use was only 0.1% of the pumpage. Mr. S. A. Charles (Lexington, Ky.) advocated metering all water supplied to the city (for fire, street sprinkling, etc.), and charging for all in excess of a fixed amount.

Cases of pure stealing of water were cited in abundance. Nearly every water-works superintendent had his story to tell in this connection. Stealing seems to occur most persistently in case of fire services laid into private property for supplying automatic sprinkler systems, private fire hydrants, etc. As these service pipes are (usually) not metered, water stealing readily suggests itself to the user. The judicious control of plumbers, advocated by Mr. D. R. Gwinn (Terre Haute, Ind.), may greatly help to reduce loss of water through surreptitious house service connections to the mains.

The waste of water by private consumers is often a question of rates. If the rates are so adjusted as to make a metered supply a manifest economy to the user, waste of this kind is largely done away with. For the rest, thorough inspection is a great help, in detecting leaky fixtures, fixtures in excess of those paid for, sprinkling in prohibited hours, etc. The matter of rates was discussed as a separate question from waste, but the two subjects are evidently in close connection.

THE INSPECTION OF FIXTURES.

This subject was treated by Mr. H. C. Hodgkins (Syracuse, N. Y.), in a paper on "The Necessity of a Systematic Inspection of all Water Services and Fixtures." While recognizing the waste-prevention reason, the author put his main plea for systematic and thorough inspection on different grounds, viz.:

(1) To obtain a correct invoice of all property in the way of services and consumers, (2) to obtain an invoice of the possible additional business that can be obtained and (3) incidentally to secure as much of this business as possible, (4) to discover all uses of water which may not be charged for, (5) to discover all defective and leaky fixtures, (6) to obtain a list of all services or fixtures available for two or more consumers or for purposes for which they were not intended, (7) to discover any defective improperly laid services, any improper or concealed connections or extensions, and (8) to indicate what services it is impossible to supply except through meter. Proper methods of inspection are also outlined in the paper.

Mr. W. S. Crandall (New York, N. Y.), in a paper entitled "Water Waste and Its Prevention," speaks in favor of the Deacon waste-detecting meter system, used much in England. But while in that country American water meters are not highly thought of, Mr. Crandall takes quite a contrary position, and recommends where possible a full installation of meters. Where this can not be done, he would use the Deacon system rather than house-to-house inspection, as being more thorough and cheaper. In discussion, it was stated that a good method of waste detection was to connect two hydrants on opposite sides of a gate-valve in the main by a hose in which a meter is inserted. This, in conjunction with the service meters, shows leakage at dead-ends, in mains, etc.; or, all services on the section supplied may be turned off in succession, the meter in the hose by-pass showing the consumption in the remaining ones.

What can be done by an inspection which examines possible sources of waste was clearly shown by Mr. H. A. Dill (Richmond, Ind.), in a paper entitled "Results of An Investigation of Amount of Free Water Supplied to the City of Richmond, Ind." It was found that factories and livery stables, users of water motors, elevators, etc., wasted much water. These services were metered, with satisfactory results (elevators metered only in cases of neglected repairs). Sewer flush tanks, city buildings, and public drinking fountains, which are supplied with water free of charge, showed enormous waste of water. Flush tanks often flushed many times a day, or else allowed water to run through without flushing. Drinking fountains were also found to be very wasteful. All these wastes have been greatly curtailed by proper repair, in which the city co-operated willingly after being informed of the conditions. Discussion on this paper showed a sentiment for fitting meters to all flush tanks. In some cities this is already done, the meter being a simple orifice of definite size (1-16-in.). One city, Newport News, Va., used ⅝-in. water meters on flush tanks, and the filling faucet is operated by hand; the flushing is done once a week.

WATER RATES: METERED SERVICES.

The paper on "Water Rates," by Mr. H. O. Nourse (Chicago, Ill.) enumerated briefly the factors affecting the rates to be charged for water. Primarily all elements of cost of supply affect the rates to be charged in an equal manner, but the number of customers, availability of other sources of water, and the laws governing the sale of water, are also important factors. The paper then referred to various methods of charging (other than meter rates), particularly to the plan followed in Chicago:

The rates in the city of Chicago are based upon what is known as the frontage plan; that is to say, upon the width of the buildings in feet and the height in stories. An average residence in the city of Chicago would be one 25 ft. wide, built upon the average 25-ft. lot, and two stories high, the rate of assessment per annum being $8.50. A building of this character occupied by two persons, say a man and a wife, pays to the water fund this amount without regard to the fixtures used within the building or the small number of persons consuming water. The same building may contain, under the law without additional charge, twelve persons, and it is fair to presume on the theory of average, that twelve persons will use six times as much water as two persons.

Again, a flat or apartment building 25 ft. wide and two stories high is assessed, in Chicago, for frontage the same as a residence of this size, viz.: $8.50, and an additional charge of $7.00 for the fixtures (bath, bowl and closet) for the flat in excess of one, making $15.50 per year. If a man and wife (two persons) occupy the lower flat and two persons occupy the upper flat, the four persons pay into the water fund $15.50 per year. Under the law, 12 persons may occupy each flat, making possible the consumption of six times as much water as four persons would use, without the payment of any additional sum. In the case of a private residence, the revenue, without regard to the number of persons, is $8.50; whereas, in a flat building, the revenue without regard to the number of persons, is $15.50. This character of inequitable results is possible from each and every one of the plans.

The author's advice is "Keep away from the assessed rates plan and meter every service." The paper concluded with a plea for thorough and clear accounting, and if possible uniform accounting.

In discussion, Mr. H. E. Keeler (Chicago, Ill.) enlarged on the theme of what factors enter into cost of system, and claimed that often the accounts of municipally-owned water-works do not show all the cost items, that interest on the entire investment is not charged, and taxes are not included. He further deprecated the tendency to make laws to the disadvantage of private companies, claiming that capital would be scared away so that towns desiring water-works could not get them. Concerning problems of metering, Mr. L. N. Case (Duluth, Minn.), cited an instance where a man whose service had been metered later sued to have the meter removed, as it made him pay more than the old flat rate. He failed in his suit. Mr. Case found that in about two-thirds of all cases of metering the consumer paid less than he would under the flat rate, while about one-third paid more. Mr. A. W. Barron (South Bend, Ind.) pointed out the analogy with gas and electricity supply, the former all metered in this country, the latter nearly all. He suggested concerted action of the members in forcing the universal adoption of meters. Some one suggested that this would be unfair to many private companies, whose gross receipts would be cut down to insolvency by the adoption of meters. It was answered, however, that this only proved the meter rates to be too low compared with the flat rates. In Milwaukee the meter rate has been lowered so as to induce everyone to put in meters, and the rates have been equalized for small and large consumers. That there is often strong objection on the part of the consumer to put in a meter was illustrated by several cases from Chicago, cited by Mr. Nourse, where political influence had been used to keep the meter out. Mr. J. O'Shaugnessy (Columbus, O.), who has put in 7,000 meters in the past 12 months, stated that 95% of the objections to meters came from tenement houses, where the tenants did not care about economy in water, and the landlords therefore object to meters or else raise the rent.

CAST-IRON WATER PIPE.

The association's committee reported that the New England Water-Works Association had exhaustively studied the subject of cast-iron water pipe, and had drawn up standard specifications as a result of that study; the committee recom-

mended that these specifications be adopted, although it called attention to the strength requirement as being probably undesirably high for some parts of the country. Attention was also drawn to the fact that manufacturers were inclined to object to the clause making the engineer the judge of quality, but the committee considered this clause proper and desirable.

A paper by Mr. J. T. Fanning on "Thickness of Cast-Iron Water Pipes" was read by title. As printed in advance copy, the paper is an endorsement of the New England specifications and a brief discussion of the conditions of design which affect required thickness; this discussion has the object of aiding in selection from among the various thicknesses provided by the specifications for each size of pipe.

A vigorous protest against adoption of the specifications was raised by Mr. Geo. H. Benzenberg (Milwaukee, Wis.), and as a consequence of that protest (there was no further discussion of the subject) the association continued the committee for further consideration of the subject, as already noted. Mr. Benzenberg's argument was, in brief, that the specifications as drawn represent present and conservative practice, and for that very reason would hamper future advance. He pointed out that while pipe is far the largest item in most water-works systems, there had been practically no advance in pipe-making since the first use of cast water pipe in Brooklyn, N. Y. Adopting these specifications would act to prevent any advance being realized, as manufacturers would demur to exceeding this specification as a maximum limit. Cleaning and coating are much neglected in the specification, just as it is generally neglected or scamped in practice. Mr. Benzenberg concluded by saying that the association might *approve* the specifications, but should not *adopt* them.

ELECTROLYTIC CORROSION.

This subject was introduced by a paper on "Some Recent Effects of Electrolytic Action on Underground Pipes and Other Metals," by Mr. A. A. Knudson (New York, N. Y.). This covered substantially the same ground as the paper read by the same author before the American Electrochemical Society a few months ago (see Eng. News, April 23, 1903; p. 373). An interesting paper was read by Mr. D. H. Maury (Peoria, Ill.), under the title "Surveys for Electrolysis, and Their Results." The author describes the method of conducting such electrical surveys, which he advises every water-works superintendent to undertake, and gives tables for finding the current in various sizes of pipe with different potential drops. Electrolytic corrosion at the pipe joints is then specifically emphasized as an often unsuspected source of trouble. The author concludes with the demand that all street railway currents be absolutely removed from the ground, which is possible, since the double-trolley system has proved itself practically and economically suitable.

The same demand was expressed a year ago in the report of the association's committee on electrolysis. The committee also reported at the present session, but merely reiterated that demand.

Prof. E. W. Bemis (Cleveland, O.), in discussing Mr. Maury's paper, asked for definite information as to the working of the double-trolley system, and stated that while it is believed that the Cincinnati line of this type is an entire success, the company owning it has been able to suppress nearly all evidence concerning its working. In answer, Mr. Maury stated that the Cincinnati line was in every way successful, that Washington, which uses the conduit system within the city, employs the double-trolley outside the city, and that several European lines of this type have been working for some years with full success. He pointed out that the added cost of the extra trolley wire, etc., was partly offset by more economical working and by the saving of rail-bonds. Mr. C. E. Rowe (Dayton, O.) mentioned that often softening of the pipe occurs long before a break, and without surface indications, for which reason pipe uncovered for examination should be probed for soft spots. He also spoke of the large return-feeder cables used in Philadelphia to keep down earth currents, and stated that the city authorities there keep constant watch over the electrical conditions of the ground, and, when perceptible potential differences are found, force the street railway company to make additional feeder connections. But in spite of this, Mr. Knudson stated, electrolytic corrosion of pipes does occur in that city.

CRENOTHRIX IN WATER MAINS.

Prof. E. G. Smith (Beloit, Wis.), detailed trouble with Crenothrix in mains, under the title "Some Recent Experiences with Growths In Mains." First discovered in Silesia, in 1852, where it grew in some drain-pipes, the plant-growth Crenothrix appeared in the water-supply pipes of Berlin in 1871, and since then has been found in several systems abroad and in a number of water-supplies of the eastern United States. Three kinds have been distinguished, feeding, respectively, on iron, manganese, and alumina (in the dissolved and sub-oxidized state). The iron-consuming variety is most common. The minimum amount of dissolved iron necessary for the growth of the plant seems to be 1 part in 1,000,000, or even less. The author recently studied several cases of occurrence of Crenothrix in the Middle West. At Duluth it was attempted to use water from wells sunk in the sands of Minnesota Point. After a time this water acquired an unpleasant odor, and examination showed abundant growths of Crenothrix in the pipes. The city is now building aeration works and sand filters to free the water of iron before delivering it to the mains; the plant cannot flourish in water containing only fully oxidized iron. At Freeport, Ill., the pumps and service pipes were badly clogged by the growth, and a lime treatment plant is now being built for the removal of the iron in the water. The worst conditions exist at Wausau, Wis., where all the mains (recently opened) are found to have a thick interior lining of black powder, which the microscope shows is Crenothrix and its debris. The quality of the water there has, however, not suffered in the least. The author showed a number of microphotographs of the growth, and samples of the deposit in the Wausau pipes.

The discussion revealed that probably several other places are being troubled by this growth. Columbus, Pa., has found a deposit of material in its water pipes that is much like that at Wausau. On Staten Island, N. Y., a whole series of wells has been clogged by a mass looking like yellow ochre. Mr. D. W. Mead (Chicago, Ill.) pointed out that many well-waters in the upper Mississippi Valley carry large amounts of bicarbonate, which form deposits in the pipes, and may thus lead to the belief that Crenothrix is present. Professor Smith stated that the remedy for Crenothrix is generally simple aeration (oxidation) of the water, and subsequent filtration, before passing it into the mains. At Duluth the dead Crenothrix had imparted an unpleasant odor to the water, but there is no really harmful effect chargeable to the growth. At Wausau, as already stated, the water is clear and sparkling in spite of the thick deposit in the pipes.

INSIDE FIRE PROTECTION.

A full and animated discussion on this subject ensued on the reading of a paper by Mr. F. A. W. Davis (Indianapolis, Ind.) on "Shall Inside Fire Lines Be Metered, and Shall there be a Charge for the Service." The discussion, which occupied an entire long session, many insurance men participating, showed a general agreement that inside fire lines represent a valuable service on the part of the water-works, and should be paid for. The question then is, shall meters be fitted and the service paid for by meter, or shall a flat rate be charged? In the latter case, the matter of water stealing comes up, and much testimony was adduced by those present to show that such stealing, in serious amounts, does occur. But if a fire-line be metered, no water may pass for years, so that the service (in readiness) is not paid for. Much more important than this, however, are the objections to meters, valves, or any obstruction in the pipe, held by users and by insurance men. Meters and valves cut down the pressure head to some extent, but their chief danger is that of clogging with debris swept in from the main when the automatic sprinklers open. Every manner of scheme for obviating this, or for arranging the system so that stealing of water is impossible, were discussed. The dry-pipe sprinkler system was suggested, but was not generally considered a full solution. Placing the meter in a by-pass to the fire-line was advanced by several as the correct method. The most promising thing in this direction is a form of meter which, as was stated by Mr. French of the Boston Manufacturers' Mutual Co., is now being developed by them. This is a meter arranged in a by-pass around a heavily weighted check-valve in the fire-line. Any leakage or use of water in small amounts flows through the by-pass. When, through opening of the sprinklers or otherwise, the draft increases so as to open the check-valve, the meter register is automatically changed so as to record proportionally larger amounts of water, thus registering the total flow without introducing an obstruction in the main fire-line. An early form of this device is now being installed in Elmira, N. Y.

Cases of fire-lines supplying private fire-hydrants are harder to control against stealing than automatic sprinklers. A radical measure suggested by Mr. D. R. Gwinn (Terre Haute, Ind.) is to install the main fire-line in a tunnel large enough to allow inspection by the water department, and to branch off from this as many 2-in. pipes, each provided with a meter, as may be necessary. Each branch pipe would supply a hydrant or a section of automatic sprinklers. However, cases may arise, as one cited by Mr. S. A. Charles (Lexington, Ky.), where a fire-line is demanded which the system is unable to supply with safety to others; in the case cited by Mr. Charles, a distillery asked for a 6-in. fire-line, which was refused on the above ground.

That metering of fire-lines is necessary to prevent stealing was pointed out by Mr. H. C. Hodgkins (Syracuse, N. Y.) who stated that in case of a large and complicated private fire-system, inspection would require a permanent guard. Mr. Hodgkins recommended a metered by-pass, and a valve in the main line which would be opened by a motor whenever the full capacity of the by-pass was drawn upon. Mr. Irving (Chicago) said that in that city, where for a long time 4, 6 and even 8-in. fire-lines were allowed to be run into stores, factories, etc., without any control, the waste was such that an ordinance was passed prohibiting all such fire-lines unless metered. Meters are on the market which will not reduce the head appreciably, as shown by tests at Chicago, but other meters, as of the plunger or piston types, should never be permitted. Mr. M. R. Sherrerd (Newark, N. J.) recalled the danger of private fire-lines running at full capacity, when the fire has progressed so that the sprinklers are useless; they may then cause a shortage of supply to the fire-engines. He advised that on a second alarm a patrol should go out, properly equipped, to shut off the private line or lines. The cost of this patrol should form part of the regular charge for private lines.

A long discussion by Mr. French (Boston) of fires in mills under the jurisdiction of the Boston Manufacturers' Mutual tended to show that automatic sprinklers are most valuable preventives and extinguishers of fires. He expressed the thought that nothing would do more toward eliminating the hazard of great conflagrations than the presence here and there of buildings protected with automatic sprinklers. Therefore the water-works men should not oppose the introduction of sprinklers, but should co-operate toward their extension. He also advocated large supply pipes to make as much water available as possible; contrary to this, several had expressed the idea that a maximum limit should be set for the size of such lines because of the impossibility of supplying fire-lines and the danger to the fire engine supply if falling walls or other means should break the private line during a fire. Mr. French also argued for free private fire-lines if it can be made sure that stealing will not take place. In this he was practically alone, however, since apparently all others present, insurance men included, recognized that the service was valuable and of localized benefit, and should be paid for, since it cost money to maintain it. A good answer was also given by Mr. Thomas, who asked where the water department should stop in fur-

nishing fire protection; the same reasons would hold good for furnishing and installing the sprinklers free of charge.

LANTERN SLIDE TALKS.

As already stated, an evening session was devoted to papers illustrated by lantern slides. Prof. W. P. Mason, of Troy, N. Y., presented an interesting series of views and sketches bearing on "Some Peculiar Features of Foreign Water Supplies." The water supply systems of Copenhagen, Amsterdam, Hamburg and Altona, Tangier s Tunis, Syracuse, Messina, Gibraltar, and other foreign cities were discussed in one phase or another. Copenhagen gets its supply from a series of driven wells in chalk formation, these wells having been selected as the result of a large number of test borings. The water-bearing chalk is being dissolved more or less rapidly in the immediate neighborhood of the wells, as was shown by a contour map of the surface of the chalk. Amsterdam collects water in open canals dug in the sand-dune region along the sea-coast, getting thus a naturally-filtered rain-water supply. The same source of supply is exploited by The Hague in a somewhat different way—by open-jointed collector pipes laid in the sand at a suitable depth. (Similar collectors tried by Amsterdam were choked up by plant growths.) Hamburg and Altona, adjoining cities, take their water from the much-polluted Elbe, a tidal stream into which both cities discharge their sewage. Altona has had filters for many years, but Hamburg in 1892 was still using raw Elbe water. The terrible cholera epidemic of that year, which ravaged Hamburg, but left Altona practically untouched, taught a strong lesson, and Hamburg now has a large open filter plant on an island in the river. The soil is such that very flat side slopes must be used in these beds, and for the same reason covering is not practicable, so that the filters freeze over in winter. To clean the surface of the filtering sand in winter a special scraper has been devised, working under the ice.

Tangiers takes its water from a public well, and water carriers with goatskin bags distribute the water, after archaic fashion. Tunis takes water from a large mountain spring and conveys it to the city by an aqueduct dating from the days of Carthage. At a drop in this aqueduct is an old watermill, and it is now proposed to generate electric power here for driving pumps which are to raise the pressure on the distributing system. At Gibraltar a part of the mountain side has been cemented as a catchment area for rainfall, and the water thus obtained is stored in a series of large tunnels in the rock (see Eng. News, June 27, 1901).

At the same session, Mr. Geo. W. Fuller described, with the help of a large collection of lantern-slide drawings, the new mechanical filter plant at Little Falls, N. J., from whch the East Jersey Water Co. supplies Paterson, Passaic and other towns (see Eng. News, May 9, 1901, and April 16, 1903).

OTHER PAPERS.

A paper on "Meter Location and Meter Accounts," by Mr. S. A. Charles (Lexington, Ky.), described a home-made casing in which the meter in the service-pipe is placed. He places all meters on the curb or sidewalk lines, and for a meter box used a 20-in. sewer pipe set vertically, with a cast-iron cover, a 3-ft. extension dial and a stop valve. The author also claimed remarkable speed for his meter-reader, 400-500 meters per day. The paper advocates full and clear meter accounts (see Eng. News, March 29, 1894, for illustrated description of the "Meter System of Lexington, Ky.") Meters are tested whenever the user desires it. The cost of Mr. Charles' meter box is $3.60, plus cost of setting, which is slight. Prof. E. W. Bemis (Cleveland, O.) described a similar box or casing which he is using in Cleveland. He does not like the extension dial, and brings the service pipe up inside the casing; the casing contains a wooden frost guard. The cost of this box is about $8 50, set in place. The Cleveland climate is not too cold for placing the meters in the sidewalk line, but the casings are not opened in the very coldest weather. To prevent freezing of meters, Mr. J. M. Diven (Elmira, N. Y.) recommended placing a bunch of oily waste in the box. Mr. D. R. Gwinn (Terre Haute, Ind.) described a brick meter-well, 3 ft. in diameter at bottom and 18 ins. at top, 5 ft. deep, containing about 300 brick, which can be placed complete with cast-iron cover for $6.00, using a trained laborer to lay up the brick.

"A Simple Device for Testing Fire Hydrants," by Mr. E. L. Nuebling (Reading, Pa.), described a device for lowering a small lead weight down a hydrant pipe to see whether ice or water is present. The importance of detecting frozen hydrants in winter was emphasized by the paper. Under the title "Preliminary Steps to be Taken in Water Supply Investigations," Mr. L. J. Le Conte (Oakland, Cal.) strongly urged that underground supplies be first looked to in planning a water supply, and that filtration should be resorted to only in dire extremity. "Plumbers and Plumbing," by Mr. D. R. Gwinn (Terre Haute, Ind.), was a story of how and why a water-works manager should be politic in his dealings with plumbers, even to the point of sending each of them a box of cigars at Christmas. In discussion on this paper it was questioned whether a water-works manager could fine a plumber, and the general opinion was that in most cases this is not enforceable, unless the council will pass the necessary legislation.

Mr. N. P. Simin (Moscow, Russia) presented a paper entitled "Fire Protection Water-Works," a name he uses for such systems as give fire streams direct from the hydrants without fire engines. He reviews the difficulties in the way of this practice, and shows how he solved the problem in the systems of Samara, Russia, and Tobolsk, Siberia. The feature of Mr. Simin's plan is a valve in the service which closes when the pressure in the mains exceeds a certain amount. When a fire breaks out, the pumping station increases the pressure on the system; this closes the automatic valves, and the full pumpage at increased pressure is then available for fire streams. A project for Moscow on this plan was worked out, but has not been executed.

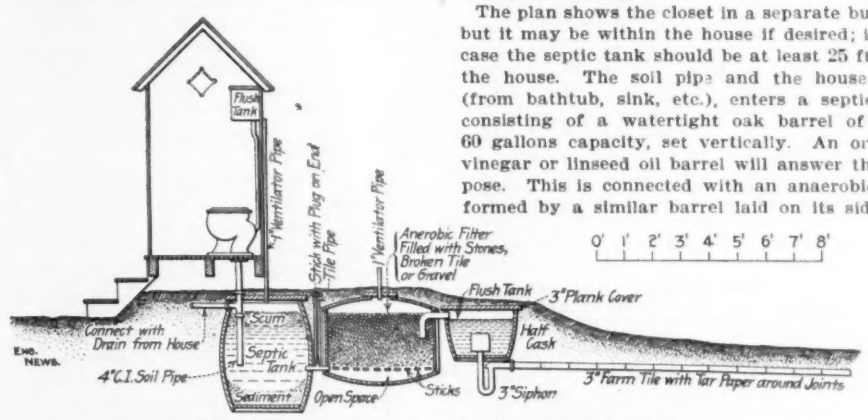
"Depreciation" was the title of an extended treatment, by Mr. J. W. Alvord (Chicago, Ill.), of the loss in value of water-works plant. The paper was too long to even briefly abstract here. It takes up the principal elements of a supply system, pumps, pipe, reservoirs, etc., and considers how they lose value. An important principle advanced is that the drop in value is slow at the beginning and more rapid toward the end of the life, i. e., the depreciation curve is not a straight line. A discussion of the same subject by Mr. D. W. Mead (Chicago, Ill.) was also quite extended. Mr. Mead drew attention to sudden changes in value, which occur at special times, as when a single element is the cause of a whole system or part of a system being scrapped. Prof. E. G. Smith claimed that contamination of source of supply was an item of depreciation, and called attention to the injustice of municipalities causing such loss to private companies by pouring their sewage into streams.

In addition to the papers presented, a list of questions awaited discussion at the close of the last session. Because of lack of time they received rather scant consideration, and only detail points were brought out.

SEWAGE DISPOSAL FOR COUNTRY RESIDENCES.

The disposal of sewage at isolated residences at country or other resorts is often an important problem, and difficult of solution. The accompanying cut represents a simple and cheap but effective plant designed by Mr. John W. Alvord, M. Am. Soc. C. E., Hartford Building, Chicago, for individual cottages on the grounds of the Shorewood Association at Saugatuck, Mich. A number of these plants are to be built during the present year, but they are only applicable where the soil is porous or sandy.

The plan shows the closet in a separate building, but it may be within the house if desired; in that case the septic tank should be at least 25 ft. from the house. The soil pipe and the house drain (from bathtub, sink, etc.), enters a septic tank consisting of a watertight oak barrel of about 60 gallons capacity, set vertically. An ordinary vinegar or linseed oil barrel will answer the purpose. This is connected with an anaerobic filter formed by a similar barrel laid on its side, and



SEPTIC TANK PLANT FOR COUNTRY RESIDENCES.
John W. Alvord, M. Am. Soc. C. E., Consulting Engineer, Chicago.

filled with stone, broken tile or gravel, of chestnut to egg size. A row of sticks is laid across the bottom. From each barrel rises a 1-in. ventilating pipe. The filter is connected to a flush tank formed by a half-barrel, fitted with a 3-in. siphon made by the Pacific Flush Tank Co., of Chicago. This discharges into an outlet drain of 3-in. farm tile, with tarred paper around the joints, one foot of tile being laid for each gallon of water used daily from the flush tank. The tile is laid loosely about 10 or 12 ins. below the surface, with a slight downgrade from the flush tank.

The above arrangement has sufficient capacity for a cottage with five to eight persons, using not more than 100 gallons of water per day. When properly installed, no care or renewals will be required. For a larger number of people, a septic tank should be added for every four persons. Such material as rags, lemon peel, garbage, etc., should, of course, not be thrown into the closet. At the beginning of the season, the plant should be examined to see that no stoppage exists to prevent proper action. At the end of the season, the water should be removed from the closet bowl with a sponge, and the plug in the pipe between the two barrels removed to allow the water to drain off. The dome of the siphon in the flush tank is also removed, and the water withdrawn from the lower limb, which is then closed by a temporary plug at the top. With the plant properly built and kept in proper condition, and with no leakage, it will operate without odor or nuisance.

The estimate of cost is as follows:

3 casks at 75 cts. each	$2.25
Sewage siphon	14.00
100 ft. of farm tile	1.00
Pipe and plank	2.50
Labor and cement	6.00
Total	$25.75

THIRTY-SIXTH CONVENTION OF THE RAILWAY MASTER MECHANICS' ASSOCIATION, SARATOGA, N. Y.

The annual convention of the Master Mechanics' Association for 1903 was held at the Grand Union Hotel, Saratoga, N. Y., on June 24, 25 and 26. During the three sessions some 20 individual papers and special committee reports and about a dozen topical subjects were presented and discussed. A few of the individual papers and committee reports were of a fair order of merit, but the majority were rather perfunctory documents. The program was too long, and discussion had in several instances to be curtailed in order to complete the allotted tasks. As a result some of the papers which were of most value received inadequate consideration, while others of less im-

portance received an undue amount of attention. A time schedule rigidly enforced would have been an aid in preventing this misuse of time and labor. Much time was also wasted in discussion not pertinent to the subject being considered. There is no wish to be captious in making these criticisms, but business quickly and carefully transacted being the object of the Association in session, they are perhaps worth recording.

BUSINESS PROCEEDINGS.

The convention was opened by the usual addresses of welcome and response, followed by the formal address of the President, Mr. Geo. W. West (N. Y., Ont. & Wn.). The Secretary's report showed the present membership of the Association to be 752, and a balance of money on hand amounting to $3,085. The dues for the coming year were made $5 per member, as usual. The report of the Executive Committee called attention to the tests now being conducted at the expense of the Association, and to the need of a greater income if this practice were to be continued. To obtain this revenue the committee suggested changing the constitution by the following amendments:

One representative member may be appointed by any railroad company to represent its interests in the association; such appointment shall be in writing and shall emanate from the president, general manager or general superintendent. Such member shall have all the privileges of an active member, including one vote on all questions, and in addition thereto shall, on all measures pertaining to the determination of what tests shall be conducted by the association or the expenditure of money for conducting same, have one additional vote for each full 100 engines which are in actual operation or in process of purchase by the road or system which he represents. Such membership shall continue until notice is given the association of his withdrawal or the appointment of his successor.

Representative members shall pay, in addition to their personal dues as above, an amount for each additional vote to which they may be entitled, as shall be determined each year by the Executive Committee, prorated upon the cost of conducting such tests as may be determined upon at each convention, provided that no such assessment shall exceed $5 per vote per year.

This amendment will be voted upon at the convention of 1904.

An announcement was received from the Pennsylvania R. R. concerning a locomotive testing laboratory which it plans to establish and operate at the St. Louis Exposition, and asking the Association to appoint a committee of three members to assist in laying out a program of te ts. There was appointed as this committee Messrs. F. H. Clark (C., B. & Q.), H. H. Vaughan (L. S. & M. S.), and C. H. Quereau (N. Y. C. & H. R.).

A request from J. T. Ryerson & Son that the Association accept and arrange the disposal of a scholarship in mechanical engineering in any college in the United States, was received and the offer was accepted. The scholarship gives the recipient $600 per year for four years, and is one of three inaugurated by the firm named.

The following officers were elected to serve the Association during the coming year: President, W. H. Lewis (Norf. & Wn.); First Vice-President, P. H. Peck (Chic. & Wn. Ind.); Second Vice-President, H. F. Ball (L. S. & M. S.); Third Vice-President, J. F. Deems (Am. Loco. Co.); Treasurer, Angus Sinclair.

TECHNICAL PAPERS AND REPORTS.

The number of the technical papers and special committee reports which came before the convention for consideration was so large that only a brief summary of the more important ones and of the discussions which followed them is attempted here. Those who are interested enough in any of the papers to obtain them in full can do so by ordering them from the Secretary, Mr. Joseph Taylor, Rookery Building, Chicago, Ill.

TON-MILE STATISTICS.—The committee on this subject confined its work to the consideration of the proper ton-mile credit for switch engines, and the bulk of its report was made up from the results of an investigation of switch engine mileage conducted by Mr. George L. Fowler for the "Railroad Gazette," and printed in that journal for May 8, 1903. Mr. Fowler's figures showed that the average mileage per hour of switch engines varied from 2.31 miles for freight engines to 2.78 miles for passenger engines. As the present credit for switch engines is six miles per hour, and as all costs of maintenance per engine-mile are now based on this hourly mileage, the figures given by Mr. Fowler caused some consternation and a vigorous protest was made by a number of members against any notion of changing the present six miles per day credit. Stripped of verbiage the argument of one set of members was: Switch engine costs are already high on a six miles per hour credit, and if this credit is cut in half they will compare still more unfavorably with the road engine costs; that of the other set of members was, if the facts are that switch engines are doing only half the mileage with which they are credited then recognize this fact, whatever the costs per mile may be as compared with road engines, and then seek a remedy for the trouble, if there is one. The dispute raged rather fiercely, and as there seemed to be no chance of the two sides agreeing it was temporarily compromised by continuing the committee with instructions to confer with the committee of the American Railway Association and report results at the convention of 1904.

BEST TYPE OF DRAWBAR BETWEEN ENGINE AND TENDER.—This subject was treated in an individual paper by Mr. Henry Bartlett (B. & M.). The author pointed out that the fundamental elements of a drawbar attachment between engine and tender were: (1) The drawbar itself, which receives the tensile stresses; (2) the buffers, or chafing irons, which receive the stresses of compression or impact; and (3) the safety device, which comes into play only in case of failure of the drawbar. A study of present practice showed that the straight horizontal drawbar was universally favored; that favor was divided between spring buffers and rigid chafing blocks, and that "safety chains" was the most common safety device. The author recommended a straight drawbar of rectangular section, with its broad face horizontal and with its ends reinforced by hubs. The working stresses in such a bar should be 4,000 lbs. per sq. in. He considered that no form of spring buffer had proved thoroughly successful, and questioned the principle upon which this design was founded. There were two possible solutions of the buffer problem: (1) The use between engine and tender of some form of coupler resembling a M. C. B. vertical plane car coupler, modified to adjust itself more comfortably to sharp curves, or (2) to revert to the first principle of the adjustable wedge in taking up the slack.

The discussion on this paper was opened by Mr. Wm. Forsyth, who pointed out that while the writer of the paper condemned the spring buffer others were equally emphatic in commending it. He asked why it would not be a good plan to use a friction draft gear between engine and tender. Prof. H. Wade Hibbard considered that the connection between engine and tender should be essentially such as to render the two a single unit and for this purpose he saw no better solution than the adjustable wedge suggested in the paper. Mr. J. L. Lawrence (Cumb. Val.) stated that in his experience with the wedge attachment there had been trouble in keeping the wedge in place, and from the bending of the tail piece of the engine. He considered the spring buffer the best available device unless the friction draft gear could be developed to supersede it. Mr. H. H. Vaughan (L. S. & M. S.) spoke in favor of the spring buffer and had had satisfactory results with one in which a broad contact between buffer and friction plate was provided. In many spring buffers the narrow contact between these two parts caused trouble from grinding and cutting. Mr. D. Van Alstyne (Chic. & Grt. Wn.) regarded the spring buffer as preferable and necessary, but that to get the best success with them they should have broad wearing surfaces as suggested by Mr. Vaughan. He did not believe that a solid wedge arrangement could be devised which would not wear rapidly. Mr. C. H. Quereau (N. Y. C. & H. R.) had found the wedge arrangement to wear rapidly and difficult to keep in position. His experience with the spring buffer had been more limited, but so far as it went was also more favorable.

ELECTRICALLY-DRIVEN SHOPS.—In this report the committee discussed principally the advantages of electrical speed control and the best system of obtaining it. Basing its estimates on the construction and equipment of the Collingwood shops of the Lake Shore & Michigan Southern Ry. the committee calculated that the total annual cost of operating a tool with electrical speed control, as compared with constant speed motor driving, showed an increase of 2.24%. The committee concluded that

In general it may be stated that while close electrical speed regulation may not be theoretically necessary, it presents a practical method of increasing the output from shop machinery that can not be approached by the old belt and cone pulley, and that this increase in output should largely outweigh the slight additional cost, and in any shop where this small increase in outlay can be made in order to effect a substantial economy in operation. In other words in any shop that is laid out on reasonable business principles, some form of speed control should be applied.

Regarding the available systems for obtaining speed control the committee reported as follows:

There are at present in use a number of different systems of electrical speed control, all of which are probably satisfactory in operation. They have had in the past one decided feature by which they might be classified, the extent to which it was thought necessary to vary the speed of the motor, some systems employing a speed variation of 1 to 2 or 4, others a decidedly larger range of from 1 to 5 or 8. The question is one of the size of motor desirable to employ to drive any given tool and is thus partly commercial, the larger motor required for a wide speed variation being of course more expensive, and partly one of convenience, the smaller range systems requiring addition gear trains on many tools which can be avoided by increasing the speed variation of the motor, and conversely the large motors are inconvenient to apply and occupy valuable room in the shop. It may be safely stated that this question is being gradually settled as experience is developed and that a range of 1 to 3 or 4 will be very generally agreed on as the largest it is advisable to obtain by electrical means. This range is being now obtained under two distinct systems, one in which three wires are used, giving voltages in the ratio of 1 to 2, the other, in which four wires are used, giving voltages in about the ratio of 1, 1⅓, 1⅔, 2.

The report discussed the advantages and disadvantages of three-wire and four-wire control at length, and concluded as follows:

Your committee in general feels that on this subject the time is not ripe for any definite statement; the two systems referred to are both coming into use and their merits will be decided on the field of service. The chief features on one side and the other appear to be, the use of a special motor and one extra wire on the one side as against a standard motor and two extra wires on the other. There does not seem to be any great advantage in cost on one side or the other so far as investigation of the regular prices can determine where the cost of wiring is considered, and apart from this question, which is, perhaps, the most important one in the long run, the points deserving careful attention in considering the design of a plant would be the equal capacity of the motors offered for standing overloads so far as both heating and commutation are concerned, the speed of the motors at the maximum, which for equivalent cost it is desirable to keep equally low, the controller employed, the latter being quite an important detail of the apparatus, and the elimination of armature regulation beyond the limits referred to.

In presenting this report, Mr. C. A. Seley (C., R. I. & P.) emphasized the importance of electric driving for railway shops, and enlarged upon the advantages of the three-wire system of speed control. Mr. L. R. Pomeroy (Gen. Elec. Co.) pointed out that the opinion seemed to prevail that speed control obtained by field manipulation was not legitimate, and rather of the nature of a makeshift. He desired to go on record as stating that varying the speed of a motor by means of field manipulation was commercially feasible and mechanically and electrically practicable, and, further, that it was the handiest and simplest method of obtaining such variation. Mr. H. H. Vaughan (L. S. & M. S.) wished to emphasize strongly the fact brought out in the report that an additional 2% in output would pay for the additional investment to secure variable speed control. He did not think there was any good reason why a machine tool ready for variable speed motor connection could not be bought for as little as one ready for belt connection as soon as toolmakers awoke to the fact that such tools were demanded.

LOCOMOTIVE FRONT ENDS.—This report presented the conclusions from the results of the tests conducted at Purdue University for the "American Engineer." The committee asked to be continued in order that it might make investigations of inside stacks, draft pipes in connection with outside stacks, false tops within the smokebox, and the necessity of diaphragms. The only discussion was of the nature of commendation for the work done and argument in favor of the continuation of the committee. The committee was ordered continued by vote of the convention.

SPECIFICATIONS FOR LOCOMOTIVE AXLES AND FORGINGS.—The committee on this subject presented tentative specifications for

driving axles, for locomotive forgings, and for blooms and billets for locomotive forgings. The main requirements of the driving axle specification were as follows:

Material, open-hearth steel; chemical requirements, maximum phosphorus 0.05%, maximum sulphur, 0.05%, maximum manganese, 0.6%; physical requirements, tensile strength not less than 80,000 lbs. per sq. in., minimum elongation in 2 ins. 20%, minimum reduction of area 35%. One test per week will be required, the test specimen to be taken with a hollow drill from either end of any axle half way between the center and the outside, the hole to be made by the drill to be not more than 2 ins. in diameter nor more than 4½ ins. deep. The standard turned specimen ½-in. in diameter and 2 ins. gage length shall be used to determine the physical properties.

In commenting on the method described for selecting the specimen the report said,

The above specification for locomotive driving and truck axles is believed to be fair to both manufacturer and purchaser. The physical test outlined is one which should insure proper hammer work and it has also the following further points in its favor: (1) It does not show the manufacturer which axle is to be selected for test. (2) The axle tested is not destroyed, but is available for use if it meets the requirements. (3) The test may be used in the purchase of small lots, most orders from railroad companies being for from six to ten axles. (4) The test does not require a discard and in no way adds to the cost of the axle. (5) It furnishes the manufacturer with a check of the work done in his plant. (6) The test is one largely used by the United States government for forgings.

The specification for locomotive forgings was exactly the same as that for driving axles, except that the test piece was to be provided in the usual manner by a prolongation on the forging. The specification for steel blooms and billets for locomotive forgings called for two grades of open-hearth steel, viz., grade A for rods, straps and miscellaneous forgings; grade B for driving and truck axles, connecting rods, crank pins and guides. The specified physical and chemical requirements are summarized as follows:

	Grade A.	Grade B.
Tensile strength, lbs. per sq. in.	70,000	80,000
Elongation, per cent. in 2 ins...	20	17
Minimum carbon, per cent.....0.25 to 0.4		0.35 to 0.5
" phosphorus, per cent.	0.06	0.05
" sulphur, per cent.....	0.06	0.05
" manganese, per cent..	0.6	0.6

The discussion was brief and brought out no additional information.

RECENT IMPROVEMENTS IN BOILER DESIGN.—This report was divided into two parts, the attempt being made in part one to outline concisely present practice in boiler construction as exemplified by recent work in America and abroad, while the second part endeavored by giving the miscellaneous answers to a circular of inquiry to show what troubles were being most experienced with modern boilers. This report was the only example at the convention of the almost universal question and answer form of report which distinguished the proceedings of the Association ten years ago, and it was perhaps useful as a reminder of the painful practice which the Association has happily outgrown in its mature years. The first part of the report, while it contained nothing new, was a fairly good summary of the distinguishing features of present practice, and we give here a portion of the table in which the committee summarized them, and an abstract of the comments accompanying the table:

The most prominent features of design to attract attention are those of heating surface and grate area. Professor Goss pretty nearly exhausted the boiler-power question when he said: "The maintenance of pressure in the cylinders demands steam from the boiler, and the limit of cylinder work is reached when the boiler can no longer meet the demands made upon it." This is all fundamental, though recent, but is in strong contrast with the old order of things where cylinder dimensions alone signified a powerful engine. The boiler of 1903 is designed with special reference to well-defined conditions, in which the horse-power involved is provided for by a heating surface and grate area, of proportions that are expected to unfailingly supply the cylinders. That these expectations are fully met is attested by the performance of the latest engines.

The wide fire-box which is rapidly becoming recognized as a standard form of construction is responsible for the extraordinary length of tubes on engines which, on the 4-6-2 type, reach a length of 20 ft. in some cases, made necessary by placing the wide fire-box at the rear of six-coupled 80-in. wheels. Foreign builders are regarding with favor the trailing truck design, since they gain a grate area impossible of attainment in the older form of passenger engines, and to this is due the appearance abroad of the 4-4-2 4-cylinder compounds of the Baden State Railway, with 42 sq. ft. of grate, and others. The De Glehn 4-cylinder balanced compound is also of the 4-4-2 type, although it has not the fire-box extending over frames, but the design of engine lends itself to such construction which will doubtless be seen on future engines of the De Glehn type.

A reference to the table will show how extensive has become the tendency to increase heating surfaces for the new conditions, over those recommended in the report submitted to this Association in 1897. The ratio of fire-box heating surface to total as given therein was 10%. The large fire-box heating surfaces shown are 5% and under in some instances, for which the enormous number of tubes is responsible. This is plainly evident in the Chicago & Alton 4-6-2 engine, which has the lowest percentage of fire-box to tube surface among the passenger engines. This engine was designed for an especially exacting work which demands an unfailing boiler power. The New York Central 4-4-2 engine has demonstrated the necessity of a boiler with unlimited steaming capacity, in numerous performances with a total load of engine and train of more than 730 tons at speeds of over fifty-five miles an hour.

It will be noted that the foreign engines have a ratio of fire-box to tube surface more nearly in harmony with the work of the committee referred to. The 4-4-2 De Glehn 4-cylinder balanced compound engine of the Northern Railway of France has made a record for development of a high horse-power on a very small heating surface, contending with 0.5% grades at a speed of 74 miles an hour, with 295 tons of engine and train. More than 1,500 De Glehn engines are now in service. The 0-10-0 3-cylinder simple engine of the Great Eastern Ry., has boiler proportions of the greatest magnitude of any of the foreign engines, having been designed for suburban passenger service in which stops are numerous, and with a gross load of 414 tons. This work requires the engine to accelerate quickly, therefore the small wheels and large boiler, the latter feature being an innovation in English design.

The London & Southwestern Ry. has over 100 Drummond water-tube boilers in service, and it is stated that all locomotive boilers of this road are now being fitted with cross water tubes. Under this system, the fire-box heating surface is increased nearly 100% by means of the water tubes, and equals 30.8% of the total. This would appear to be a practical illustration of the ancient proposition, that the higher percentage of fire-box heating surface to total heating surface, the greater the evaporative efficiency of the boiler, a logic that remains to be controverted. A boiler of this character, but with water tubes in the fire-box only has been designed by Mr. Riegel of the American Locomotive Co. This system contemplates two nests of water tubes extending from center of crown sheet diagonally down to side water spaces, by which it is claimed to be possible to get over 1,800 sq. ft. of efficient heating surface in the fire-boxes of the larger types of engines, making a total heating surface of over 6,000 sq. ft. There is no doubt of the necessity of such a design, since fire-boxes have about reached the limit of size, both from a clearance standpoint as well as that of operation. There is no record of any construction of this idea.

Superheating of steam is attracting considerable attention abroad, particularly on the Prussian State Railways, where 70 engines are fitted with the Schmidt system of superheating. In addition to these the Schmidt principle is in use on the Alsace-Lorraine State Railways, the Belgian State Railways, the Moscow-Kasau Ry., the Southern Ry. of Italy, and the Munich Suburban Ry. In this country the same superheating device is in use on the Canadian Pacific, and the American Locomotive Co. is now constructing another engine similarly equipped for the same road. It is understood that there are also five of these engines under construction by the Pennsylvania R. R. Very glowing accounts of the performance of Schmidt engines, by an American engineer who has recently returned from Europe, would imply that there were economics in superheating of steam for locomotives.

Even with the successful overcoming of resistance at continuous high speeds there is a question among some officials that, while we have ample heating surface, it may not be in the right place, or, in other words, it is possible that we have too much heating surface in the wrong place, that is, are not too many tubes used, and would not a boiler furnish an equivalent or a higher evaporation with a lesser number? There appears to be good reasons for questioning the efficiency of a multitude of tubes, among which are the following for reducing the number: A better circulation due to the wider spacing of centers; a reduction of liability to leakage, and longer life to tube sheet due to the greater section of material between holes. It is not apparent that there are any very serious difficulties to surmount in making tests that will demonstrate to what extent evaporation and cost of maintenance is affected by a wider spacing of tubes. Such experiments would definitely decide whether the practice of encroaching on circulation space with tubes is conducive to an economical evaporation, and in addition would no doubt incidentally furnish some needed light on the effect of a higher ratio of fire-box to tube heating surface under the new conditions. Restricted water spaces around the fire-box are well known to be inimical to a proper circulation, as well as dangerous to the sheets, and the same effects are known to operate at the fire-box ends of tubes. The wide fire-box has shown a marked tendency to crack at the sides, and as a remedy it is proposed to make the fire-box ring 4½ ins. wide on some engines now under construction.

In bracing and staying there is little to be recorded as new. In joint construction the welt type is said to be improved to an efficiency of 90% of the solid plate, and welding joints is said to be satisfactorily done, both on dome sheets and longitudinal joints, the latter, however, not continuous but at ends only.

In presenting the report for the committee Mr. D. Van Alstyne (Chic. & Grt. Wn.) called attention particularly to the information presented in the second part. This indicated that the modern high-pressure boiler can be made to do all that is expected of it in every respect except as regards flue renewals. Wide water spaces around the fire-box, especially at the crown sheet, long stay bolts, easy curves at doors and mud rings and scarfed corners in general had to a great extent done away with cracked sheets, broken stay bolts, and fire-box leakages. There seemed to be no question but that the wide grate engine was 10% more economical of fuel than the narrow grate of 40 and 42 ins., with the same heating surface. On the other hand, the wide grate was more wasteful of fuel when standing idle. There was no complaint against the steaming capacity of the modern high-pressure engines as a rule. Flue trouble, however, was general. The cause of this was one of the most important which the superintendent of motive power had at present to seek. He believed that while the lengths of tube and tube space, bad water, character of the coal burned, poor firing, and irregular feeding all contributed to leaky flues, the principal cause was the difference in temperature between the flue and flue sheet at the joint. Mr. O. H. Reynolds (Am. Loco. Co.) called attention to the fact that there were to-day engines with over 300 tubes where the spacing was not more than ⅝-in., and in his mind there was no doubt that this fact had much to do with the poor circulation in boilers. He thought that the Association should take steps to determine what effect the reduction of the number of tubes in a boiler would have on its circulation. Mr. John Player (Am. Loco. Co.) considered that the whole trouble with the present locomotive boiler resolved itself into one of circulation. The discussion then wandered into the familiar rut of flue-setting and stay-bolt breakages and brought out nothing of particular value. By vote of the convention the committee was ordered continued for another year.

INTERNAL COMBUSTION ENGINES.—This subject was discussed in an individual paper by Mr. R. P. C. Sanderson. The author called attention to the promising development of the gas engine for general power purposes and compared its efficiency with that of the steam engine. His conclusion from this comparison is fairly summarized in the following excerpt from the paper:

If we take an engine of reasonable efficiency in ordinary service (I do not now refer to the highest type of multiple expansion or condensing engines), with a reasonably good boiler, we cannot expect to get a brake horse-power for much less than 5 or 6 lbs. of coal per horse-power per hour. In the present imperfect condition of the internal combustion engine there is no difficulty in getting a brake horse-power for 1 lb. of coal per hour from producer gas, where nothing is wasted but the ashes, and, of course, some heat in the producer itself necessarily, due to the change of the carbon from its fixed form into that of fuel gas.

The only discussion was by Mr. R. H. Soule, who attacked the statement quoted from Mr. Sanderson's paper regarding the fuel efficiency of steam

Table Showing Main Engine and Boiler Dimensions of Recent American and Foreign Locomotives, Compiled by Master Mechanics' Committee on Boiler Design.

Railway.	Type.	Boiler pressure, lbs.	Cylinders, diameter and stroke, ins.	Diameter drivers, ins.	Weight—On drivers, lbs.	Weight—Total, lbs.	Heating surface of firebox, sq. ft.	Heating surface, total, sq. ft.	No. of tubes.	Tubes, length ft. & ins.	Grate area, sq. ft.	Per cent. of firebox to total heating surface.	Fuel.
American Locomotives.													
New York Central	4—4—2	200	21 × 26	79	95,000	176,000	180	3,505	396	16	50	5.1	Bituminous Coal
Pennsylvania R. R.	4—4—2	205	20½ × 26	80	109,000	176,000	166	2,640	315	15-1	55.5	6.2	Bituminous Coal
C. R. R. of N. J.	4—4—2	210	20½ × 26	85	99,400	191,000	174	2,967	325	16-6	82	5.86	Fine anthracite.
Northern Pacific	4—6—2	200	22 × 26	69	134,000	202,000	175	3,462	301	18-6	47	5	Bituminous Coal
C. R. R. of N. J.	2—6—2	200	18 × 26	63	108,000	165,000	137	1,832	249	13	54.5	7.47	Anthracite.
Chicago & Alton	4—6—2	220	22 × 28	80	141,700	219,000	202	4,078	328	20	54	4.95	Bituminous Coal
Chic., Burl. & Quincy.	2—8—0	210	22 × 28	57	187,000	208,900	195	3,827	462	15	54	5	Bituminous Coal
B., W. & Great Falls.	2—8—2	200	14 × 24 × 26	50	128,000	166,900	174	2,496	270	16-6	56	6.97	Lignite.
Atch. Top. & Santa Fe.	2—8—0	210	17 × 28 × 32	57	191,400	214,600	165	4,296	652	13-7	..	3.86	Oil.
Foreign Locomotives.													
Paris, Lyons & Marseilles	4—4—0	213	13⅞×21⅛×25⅞	78¾	74,800	99,400	129	1,934	150	11	26	6.7	Bituminous Coal
Baden State	4—4—2	235	13⅞×22⅞×25⅝	82⅝	70,500	163,700	145	2,260	279	15-9	42	6.37	" "
Northern Railway of France	4—4—2	228	13⅞×22×25.2	80⅛	71,200	142,100	167	2,275	126	13-9	26.6	7.34	" "
Great Eastern	0—10—0	200	18½ × 24	54	134,400	134,400	131.7	3,010	395	15-11	42	4.37	" "

engines and cited the engine for the Collingwood shop of the Lake Shore & Michigan Southern R. R., which by calculation from its guaranteed performance showed a brake horse-power developed from 3 lbs. of coal per horse-power hour. He also called attention to the fact that the thermal value of different gases available for gas engine operation varied in round figures from 100 to 1,000 B. T. U. per cubic foot and urged upon the members the necessity of remembering this in considering the gas engine problem.

THE METRIC SYSTEM.—In this paper Mr. Angus Sinclair added another instalment to the wearisome discussion of the metric system of weights and measures which engineers have had supplied to them during the last year, and presented a resolution for adoption by the convention which condemned all legislation in general and the bill recently before Congress in particular as being certain to result in "nothing but the introduction of confusion where we now have uniformity." In the discussion which followed, the adoption of this resolution was combated by Prof. H. Wade Hibbard and Mr. John Player, but a vote resulted in its passing by a large majority.

LIGHT FOR LOCOMOTIVE HEADLIGHTS.—The following is a brief abstract of this paper by Mr. Wm. McIntosh (C. R. R. of N. J.): Of the 42,300 locomotives in the United States, 37,459 still retain the oil lamp and planished reflector for headlights, 3,200 have electric headlights with the ordinary reflector and generating electricity with small steam motors of the reciprocating or turbine type, and 1,650 have acetylene generators mostly in connection with reflectors, but to some extent in connection with lens mirrors or search light reflectors, the latter being much more compact, powerful, reliable and durable than the former. Regarding the relative merits of the three forms of headlight systems referred to it may be stated that

> The old oil lamp, when compared with the new types of acetylene and electric headlights, cost much less for its supply of oil than the others do for carbide or steam, yet when the costs of operating it are counted carefully, including cleaning material, wicks, chimneys and burners, with the frequent losses from burning up, does not prove to be so economical after all; and it falls far behind in the candle-power of either acetylene or electricity, and failing also in entire reliability. Acetylene gas, while costing more for its carbide than oil, does not require chimneys nor expensive burners with wicks, and gives out several times the candle-power of the best type of oil-burning headlight, without bringing out criticism of its intensity. The electric headlight is more expensive in the line of first cost; also in maintenance, owing to a motor and dynamo being required to generate the current, and the amount of steam needed to operate it. The intensity of the light thrown out is objected to by some on account of the glaring properties and tendency to affect the vision of engineers approaching it, while others claim that these features are not seriously objectionable and the advantages far outweigh them.

As to the relative cost of operation the following figures from tests made by one railway are given, with kerosene costing 14½ cts. per gallon and carbide costing 5 cts. per pound:

Kind of Light.	Cost per 1,000 Engine Miles.	Relative Value of Light.
Coal oil	.1844c.	1
Acetylene	.4688c.	8
First—Electric	.2821c.	50
Second—Electric	.7109c.	50
Third—Electric	.2533c.	50

This comparison was made on the basis of 16 hours' light per 1,000 engine miles. The paper received no discussion.

EFFECTS OF TONNAGE RATINGS ON THE COST OF TRANSPORTATION.—This subject was discussed in an individual paper by Mr. C. H. Quereau (N. Y. C. & H. R.) and as it is one of special rather than general interest we give only the conclusions, as follows:

> The adoption of tonnage ratings for freight trains has reduced the cost of transportation by increasing the average trainload; by reducing the cases of doubling and overtime; by furnishing a basis of common interest for the operating and motive power departments to handle full trains, and by furnishing a fairer basis for judging operating and motive power efficiency. It seems, however, evident that, as is usual when any new plan has proved beneficial, the pendulum has swung to the opposite extreme and the maximum tonnage ratings are, as a rule, greater than the most economical ratings. At least the evidence at hand warrants systematic and scientific investigation.

LOCOMOTIVE PISTON VALVES.—The committee on this subject sought information by means of a circular of inquiry and the report summarized the answers to these inquiries and gave a large number of illustrations of piston valves and their attachments. In presenting the report Mr. F. H. Clark summarized its main features as follows:

> The committee found that as a general thing the hollow internal admission piston valve was preferred, largely on account of the fact that the valve is almost perfectly balanced as regards end thrust, while the slide valve is not. The committee found as a general thing that relief valves of some kind were used almost universally, either by-pass valve and relief valves, together in many cases, but the relief valve was used almost universally, and that in some cases there was a feeling that the relief valves were not performing the work expected of them. They were usually set a few pounds above the rated steam pressure and when needed were usually found to be cored or that somebody had set them down so tightly they were of no use. As a result some roads are taking out relief valves and putting in plugs, and with very good results. One road, the Southern Pacific, presented a design for circulating pipes which takes care not only of the operation of the water, but also acts as a by-pass valve and prevents the drawing in of hot gases from smoke boxes when the engine is drifting.
>
> As regards the shape of the rings, there was quite a difference of opinion. There has been a good deal of difficulty experienced with the L-shaped packing rings, and there has been a tendency either to drop the L-shape altogether or to shorten it up and to increase the section of the ring. Some of the rings are made of a section which does not generally appear in practice, with a short L, ¼-in., and give very good results. The inquiries of the committee with reference to the comparative friction of balanced slide and piston valves indicates as a general thing that the piston valve is more easily operated and the friction is less. Some of the members, we find, have been experimenting with a type of perfectly balanced slide valve, and with very good results. The only thing that the committee finds to be essential with the piston valve is the use of some form of flexible connection in the valve stem. It is found that it helps materially to prevent the wear of the valve and bushing.
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> The principal advantages suggested for the piston valve are the improvement in balancing, ease of handling, and decrease in wear and tear of motion work. Other claims were made for the piston valve such as reduced cylindrical clearance, better steam distribution, less cost for maintenance, shorter steam passages, decreased back pressure and larger port openings, etc. Some of these advantages seem to have considerable foundation, but in other cases there is some doubt in the minds of the committee as to whether the claim is justified. Among the disadvantages suggested are the difficulty in lubrication; in the maintenance of relief valves; broken packing rings; edges of grooves in spool breaking; liability to blow; inability to keep steam tight, and excessive wear on short stroke. One road finds that there is an apparent increased wear in the main driving box with piston valve. The committee is unable to explain it and so far no explanation has been suggested. It seems to be generally conceded that the wear of the piston valve is somewhat less than that of the slide valve, although there are some who take the opposite ground.
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> In the matter of bushings there are different claims—some use the continuous bushing and some the short bushing, some use diagonal bridges and some the straight bridges. The committee is of the opinion, however, that as between diagonal and straight bridges, the straight bridges are preferable, although there may be something in the idea that the diagonal bridges tend to prevent the breakage of rings. The others, however, are less expensive in fitting up. The committee, as the result of its investigations, recommends as follows:
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> (1) That tests be made to determine the amount of loss of steam due to worn packing rings. Such tests should include the various types of rings illustrated in the report.
>
> (2) That tests be made to determine whether the steam or the exhaust rings are the most responsible for the decreased efficiency due to wear.
>
> (3) That the question of proper lubrication of piston valves when drifting be more thoroughly investigated.
>
> (4) The attention of the committee being called to the question of valve setting in connection with the piston valve, after it was too late to include it in the circular, by one road stating that with identical valve motions, to obtain equal work, modifications in the piston valve setting must be made, it is suggested that further investigation be made along this line.

The discussion of this report was quite extended and consisted very largely of records of experience which were for the most part favorable to the piston valve as compared with the slide valve. Mr. Angus Sinclair and Mr. David Brown, however, differed from the majority of the speakers and criticised the piston valve. The principal discussion was contributed by Mr. John Player (Am. Loco. Co.) and was so concise and pertinent that we give it nearly in full as follows:

> I will say a few words in connection with piston valves, as I have probably had as much to do with them as anyone. One of the first questions brought up in the paper was the relief and the use of the hollow or solid slide-valve. The report states that the preference seems to be for the hollow valve, that is, with the exhaust cavity passing entirely through the valve. The original piston valves which were constructed, and which other roads have also applied, had the hollow cavity after the exhaust, with the supposition of producing an entirely balanced valve. We found, however, with that valve, after the period of commencement of exhaust the exhaust pressure had a tendency to accelerate the motion of the valve, or in other words, accelerate the presuure against the exhaust packing ring. There was an objection at that time, chiefly raised by engineers, to the sound of the exhaust of the piston valve, that it was muffled. It was in comparison to the exhaust of a slide valve. We also found that the exhaust was not quite sharp enough from the back of the engine, although you could run from a small-sized nozzle as with slide-valve engines, yet the exhaust did not sound as sharp and there was a tendency to close up the exhaust tips to produce the sound. To overcome that we made the ends of the followers solid and built a great number of engines with the ordinary two-opening exhaust, with the second cavity opening into the same chamber with a slide-valve. We found that the acceleration of the valve at the period of commencement of exhaust was practically not increased to any appreciable extent by making the ends solid. Shortly after that we introduced a further betterment in the adoption of the slide-valve. That was by making two exhaust cavities in the cylinder entirely separate, and carrying them upward by the exhaust pipe, and making the exhaust pipe with four openings at the base, and carrying two a portion of the way up and the other two a portion higher. The proportions of the exhaust pipe above that were approximately the same as those recommended by the association. We found by the adoption of the exhaust cavity and pipe we were able to enlarge an identically similar engine, enlarge the exhaust pipe anywhere from 3-16 to ⅜ in., showing the benefit of the solid end valve to the separate exhaust. The objection that has been raised that there was an exhaust pressure on the engine valve, does not hold. For one thing, we get a larger opening at the exhaust tip which relieves the back pressure. The indicator cards show the back pressure is lower than that in the slide-valve engine with open ends. There has been some trouble with relief valves on the cylinder head. Relief valves with piston valves are a necessity on cylinder heads, especially at high speeds. In some places they screw them down instead of adjusting them at proper pressure, and consequently they do not work. They should be made so that they cannot be monkeyed with. As to the by-pass valve, it is beginning to be an appreciated fact that by-pass valves combined with piston valves are a benefit, especially upon engines that have to do drifting. Some of the former patterns of by-pass valves that were applied to piston-valve engines were not altogether a success. The areas were insufficient in the first place, and the construction of the valve was such that they had a tendency to slip once in awhile, and sufficient attention was not paid to them to keep them in order. All that trouble has been eliminated in the improved form, and they are a necessity upon passenger and freight engines that do large business.
>
> With relation to circulation pipes, they perform practically the same function as the by-pass valve, but have a tendency to freeze up which is not a desirable feature. The results accomplished by the circulation pipe can be accomplished by a good construction of by-pass valve. As to the packing ring, reference has been made to the abandonment or substitution of some other form for the L-shaped ring. Some of them were made entirely too light in section, and the projection from the follower was entirely disproportionate to the section of the ring itself in some of the early forms. Any properly proportioned L-shaped ring is the ring to use, as it gives you a proper cut-off edge. One objection in slide valves has been there has been some trouble in springing them over, so that you start an initial strain in the metal which causes breakage afterward, but with the follower we have there is practically no breakage in the L-shaped rings if the valves are properly lubricated. Regarding the valve stem connections, they are made flexible where practicable. The valve, in my judgment, should be supported by the stems at both ends in the bushing, so as to relieve the weight of the valve on the bushing itself. I have seen valves supported at both ends that ran 2½ years, where the tool marks were scarcely worn off the bottom of the valve.
>
> The advantages in handling the valves have been treated by the previous speakers. The cylinder clearance of these large engines with slide valves is something abnormal in many cases. The clearance obtainable with piston-valve cylinders varies from 6 to 8% in a simple engine, although contrary statements have been made. I do not know of any piston-valve engine of recent design where the clearance exceeds 9%. The disadvantage of breaking of packing rings is a local matter; it is due to insufficient lubricating or a fault in the proportion of the ring itself. If proper followers are used and the rings are in proper shape that will disappear. The wear of the packing rings is also largely due to the proportion of the rings. The wear of the driving box on one road mentioned in the report, I believe, was due to the absence of by-pass valve with a proportioning of the cylinder used. I think if a by-pass valve were applied on that cylinder the trouble would disappear.
>
> With regard to the bushings, the bushings made with slightly tapered end have accomplished the same results as the ordinary bushing. The lubrication of the bushing valves is an easy matter. In some forms the lubrication is applied at both ends of the valve instead of one end with very marked benefit.
>
> In regard to Mr. Sinclair's reference to marine valves and the leakage of them, I understand that reference to be to low-pressure valves. If they had so much trouble with piston valves in marine service years ago, why is it that the British government, the United States government, and all these large transatlantic steamer lines are using piston valves? If the slide valve is better, why do they not use it?
>
> With regard to the trouble that has been mentioned in handling piston valves, as to the dropping down in the corner and the rocking of the valve motion occasioned by it, instructions should be issued to engineers for the proper handling of piston-valve engines to the effect that the lever should not be dropped down while the engine is speeding, but dropped down gradually as the speed decreases as you are going into a station. The object of this is obvious. The piston valve runs in a bushing, and not over a plain surface like the slide valve. The lubrication for the bushing and valve is taken on the metal, and the lubricating surface is that over which the packing ring travels. The surface covered by the exhaust, which is not covered by the travel of the valve when working, becomes dry and encrusted to a certain extent with the scum which you usually find in a steam chest. When you drop the lever in a gear, you have to cut that all off at one stroke, practically speaking, or else it snaps in the packing rings and the packing rings travel over it, and the fact of almost dropping the lever down at speed is one of the most serious objections in the use of piston valves. It causes practically all the trouble of breakage of packing rings and the failures of the valve motion referred to. If the valve is handled in a proper manner, not dropped down when run at speed, but as you slow down drop it down gradually, there will be no trouble experienced with the cylinder.

In addition to the reports given above there were the usual ones on subjects, resolutions, etc., which were handled in the usual manner, and call for no mention. During the convention the members were entertained by the visiting supply men on the usual elaborate and expensive scale. These visitors had also provided a large exhibit of railway motive power appliances located on the hotel grounds and verandahs adjacent to the convention hall.

PRESIDENTIAL ADDRESS BEFORE THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AT ITS NIAGARA FALLS MEETING.*

By Chas. F. Scott.†

The work of the electrical engineer is unique in this, he deals with kinetic energy. Others may deal with materials—arranging bricks and stones to form bridges or buildings which stand inert; but the electrical engineer deals with action, with energy in its moving kinetic form—not the structure, the bony skeleton, but the vital essence, the pulsing, throbbing life blood.

The engineer is defined as "one skilled in the application of the materials and forces of nature to the use of man." Once he dealt almost wholly with materials—some do so still. Others combine materials and forces. The electrical engineer deals with forces, he energizes and vitalizes the systems constructed by engineers of many kinds. Hence the phenomenal rate of electrical extension—it is not a new thing separate and apart from other things, it enters into them, operates, awakens, unites, combines, transforms.

Among the various branches of engineering many are of old standing and have been developed during many years; the greater part of what is standard to-day may be found in the text books and the treatises of 10 or 20 years ago. On the other hand, the second edition of Kapp's "Electric Transmission of Energy," which is less than 14 years old, contains no reference whatever to the commercial use of alternating current, even as a possibility of the future.

If one were about to install a long-distance transmission plant he could call as advisers hydraulic engineers who have had many years of experience. But if he seeks those who have had practical experience with the highest voltages he will find the plants which have been operating at 40,000 volts for more than two years may be counted upon the fingers of one hand or even upon the thumb. Nevertheless, there are under consideration a number of enterprises involving 50,000 volts or over and the transmission of hundreds of thousands of horse-power.

Note how electrical and other interests are interdependent. The underground railway systems in New York city require the work of almost every branch of engineering. The purpose of the whole is the operation of trains. Everything contributes to that end. The operation is by electricity. So also does every department of the system come into relation with the electrical engineer—the design of the power house, of the locomotives or motor cars, of the tunnel, of the track, of the stations, the arrangements for handling passengers, all are related in some way to the electrical system. And naturally so—they all are the passive elements contributing to the one active end, train operation, and electricity is the immediate active element by which trains are operated. Hence in general all else is adapted and contributes to the electrical system and must harmonize with it. Hence the electrical engineer is the central engineer, he more than any other comes in contact with all; he more than any other needs to know something of all other departments and professions.

The aim of the old-time military engineer was destruction, the object of the modern engineer is construction, the function of the coming engineer is operation.

In this new era the American Institute of Electrical Engineers represents the profession which is youngest in years, yet foremost in activity. To meet the present demands of this new era, to prepare for an expanding future, we may well ask, What should our Institute be? What should it do? Shall we adopt the methods of the old-time learned society? Shall we imitate the ways of societies in professions whose methods are established and whose rate of change is slow?

A year ago when your votes had imposed the coming responsibilities of the presidency upon me, it seemed that about all that could reasonable be expected would be to maintain the level of excellence attained in the prosperous year under my honored predecessor. It occurred to me, however, that while the preceding year had fixed a high standard for our monthly meetings in New York, we should develop next some method by which distant members might take much more active part in our work.

In my address last September several specific ways were proposed by which the work of the Institute might be advanced during the year. Let us review them briefly, noting their bearings upon the future.

(1) "The membership should be increased."

My own convictions were expressed during the year in the following words: "We have failed to catch the spirit of the times and the keynote of electrical progress if we do not realize that we must expand and broaden and progress as well as maintain high standards of excellence. Full membership should be exclusive, associate membership should be inclusive."

Our membership list on Sept. 15, 1902, included 1,630 names. Since that time nearly 1,000 applicants have been elected as associates. Who are the men who have come among us? What is their age, what has been their training, what is their present position?

The new men range in age from 19 to 65. The ages of those who have been elected are given in the following table:

Over 50 years.....	2%	30 to 35 years.....	24%
45 to 50 "	2%	25 to 30 "	34%
40 to 45 "	6%	20 to 25 "	21%
35 to 40 "	10%	Under 20 "	1%

Approximately 60% are between 25 and 35 years of age and are presumably young men who are getting under substantial headway in life and are in their accelerating period.

Forty-four per cent. of these men are graduates of schools of recognized standing. Of the graduates 45% graduated within the past five years (not including 1903), and 77% within the past 10 years. Cornell University leads the list with 12% of the graduates; the Massachusetts Institute of Technology is second with 8%; Columbia, Purdue, Ohio State, Princeton, Worcester Polytechnic Institute, Lehigh, University of Michigan and the University of Wisconsin follow next, and there are substantial numbers from McGill, Stevens Institute, University of Pennsylvania, University of Illinois, University of Minnesota, Pennsylvania State College, University of Nebraska, University of California, Harvard, Yale, and Rose Polytechnic Institute. In addition there are graduates from as many other institutions, as well as many others who have not taken degrees.

The position and occupation of the new members is difficult to classify definitely and satisfactorily, but a general summary shows the following:

Electrical engineers with manufacturing companies.	30%
Electrical engineers with operating companies.....	25%
Managers and superintendents, duties presumably executive rather than technical	16%
Consulting engineers	10%
Electric engineers with mills, mining plants and the like.....	6%
Students	6%
Professors and instructors	4%
Mechanical and electrical draftsmen.....	3%

I think we may congratulate ourselves that our additions are truly representative of the electrical engineers of America.

Other plans proposed at the beginning of the year were that:

(2) "Papers and discussions should be contributed from a larger proportion of the membership."

(3) "Local meetings of the Institute in various cities will broaden the interest of its work and generally extend its benefits."

(4) "Universities and technical schools with electrical engineering departments may organize local meetings of the Institute."

These three lines of activity have developed most satisfactorily and are closely related to each other. General plans were presented for the formation of local branches and such branches have been formed among members in a number of leading cities; also in many of the principal technical schools and universities. In some cases local members and students unite. The methods have been simple, there is a minimum of organization and formality; the primary purpose is to bring electrical men together, to awaken interest, to consider and discuss important engineering topics. At the beginning of the year definite subjects were assigned for each month for the meetings in New York. Usually several papers were secured from experts upon each subject. Printed copies of the papers together with the stenographer's report of the New York discussion have been sent promptly to the secretaries of the local branches. As the meetings of branches are usually held subsequent to the meeting in New York, they have the advantage over the first meeting in having the discussion as well as the papers. This material is presented in suitable form by the members of the local branches and the discussion is continued. Such material as is new and valuable is reported to the Secretary for publication in the Transactions. By this means the latest phases of electrical engineering work are presented and discussed, not in one meeting only, but in more than a score. Those who have taken up the local work usually report that the interest, the activity and the attendance surpass expectations. In nine cities in which local branches have been formed the total membership has practically doubled. The attendance is not limited to members, as others interested are welcome. A number of professors have spoken of the interest taken by students and the avidity with which they enter into the work. One professor recently remarked to me that the Institute papers were giving him a new insight into present electrical engineering and such papers as those upon central station practice made him realize how far practical engineers were in advance of the lecture room and the laboratory.

At the beginning of the year it was indicated further that:

(5) "The collection of engineering data and the establishment of standard practice in electrical engineering is one of the important functions of the Institute."

The present years are formative years. Electrical engineering is crystalizing. In addition to our Committee on Standardization, two new committees have been formed, one on High-Tension Transmission, the other on Engineering Data. The Transmission Committee is collecting specific data with respect to present practice in high-tension transmission and will formulate this data for the use of electrical engineers.

The Committee on Engineering Data has been appointed for collecting and publishing electrical engineering data upon new and special subjects which are evolving daily throughout the country in the practice of the engineering profession. There is much important data which has not found its way into text books and hand books and about which little is generally known. Such data, if allowed to follow existing channels, either never reach the public, or only after a long period. The committee is composed of men of high standing under the direction of the electrical engineer of the Niagara Falls Power Co. The first subject to be taken up for investigation is insulated electrical conductors. Under this general subject is included the heating of cables of various character under different conditions, the life of cable insulation, the methods of ventilation in conduits, the effects of short circuits and general data bearing upon the operation of cable systems.

The crowning event of the year was in a measure anticipated by these sentences of last September:

(7) "Permanent quarters for the Institute should be an object of plans and anticipations. . . . Personal acquaintance and social intercourse are influential factors in unity of sentiment and of action."

The story of our Library Dinner with its distinguished guest, who spoke in happy mood of American engineers and of co-operation among them and of "institutions like this of the Electrical Engineers which do so much," is already familiar to you, as well as the events of the following day when he called to his house two of our members to talk further of what an engineering building should be and of plans for its realization. I count as the most memorable privilege of the present year the opportunity given me of sitting next to Mr. Carnegie on the evening of our Library Dinner and the hour in his own library on the following afternoon. He was in the best of spirits, alert and ever interesting as conversation shifted easily from one topic to another. The talk was pleasant and appropriate to the hour, but never trivial. As one topic after another came up it was the more serious, the more definite, the substantial idea which he brought out before turning to something else. The happy response to his toast was almost throughout a repetition of the ideas and the sentiments which he had expressed in the conversation of the preceding hour.

In discussing at his house the next day the project of an engineering building he impressed me as seeking the way and the means by which he could realize an ideal. He was not very familiar with the organization of the several engineering societies, he knew little of their methods and of their financial means and their facilities. But he saw a need, not merely the physical need of accommodations, but the higher need of elevating and developing engineering and engineers. He used about these words: "Yes, engineers need to get together, they need to get acquainted and to meet socially. You can provide for that, can you not?"

In his address as President of the Iron & Steel Institute since that time he has discussed methods of industrial organization, particularly the relations between men, and he has emphasized the advantages of a general partnership and common co-operation.

When a few days after our first conversation estimates and a general scheme of procedure were presented, Mr. Carnegie did not care to go into the details of method. He seemed to have confidence that engineering organizations could develop their plans in the ways which would be most efficient. He set no restrictions. The great Gift to Engineering is presented in a single sentence shorter even than the superscription of the letter which proffers a million dollars.

Four of the organizations (the fifth has not yet taken final action) which were designated in the letter have without hesitation formally accepted the administration of this generous gift to engineering and their representatives are now actively developing plans. These plans look forward to the realization of an ideal long cherished by some of the foremost and far-seeing engineers of the country, an ideal in harmony with the new era in engineering and with the trend of American development, an ideal which brings within its scope the advancement of the engineer and of his profession both within itself and its outward relations. In short, an ideal the realization of which will strengthen modern engineering, which is the very basis of prosperity and of progress, and will exert far-reaching influences which are beyond our power to discern.

The remaining specific way mentioned at the beginning of the year for advancing the interests of the Institute was:

(8) "Co-operation with similar institutions in other countries."

Our relations with the Institution of Electrical Engineers of Great Britain in particular are most cordial and beneficial, and we are planning to have its members with us at the time of the Engineering Congresses to be held at the St. Louis Exposition next year. But the idea of co-operation has had its development along domestic rather than foreign lines. It is not worth while here to recount

*Condensed from the original.

†Chief Electrician, Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

the advantages of co-operation. We recognize it as the modern method. The possibilities which may come through co-operation among engineers and in engineering work are hardly less than those which are recognized in industrial, commercial, financial and social affairs. The founding of the John Fritz Medal and the gift of a Union Building are magnificent examples.

In the interrelations between societies care must be taken that individuality and freedom for individual development are unrestricted, and that the points of contact and common endeavor are only those in which the most efficient results can be obtained through co-operation. I think that all will agree that just as electricity has been pre-eminently the unifying element in modern affairs, so also the electrical engineer should be a unifying element in the engineering profession and that there should in particular be a co-operation among electrical organizations. Let us develop the ideal and then realize it as best we may step by step in the future.

To present definitely a general scheme I will give the substance of a suggestion which I presented to our Committee on Affiliated Societies which now has the general subject under its consideration.

1. A plan should be outlined providing for special departments or sections of the Institute for such lines of electrical work as may demand greater attention than can be given by the Institute as a whole and which can be more efficiently conducted in this manner than by the formation of new specialized societies.

2. Affiliation or co-operation is desirable with the other electrical associations by which the Institute may work in harmony along certain lines, such as standardization, adoption of the national electric code, the collection of engineering data and other matters of a general nature. Many associations dealing with specific industries have both commercial and engineering interests. I would make the Institute the electrical head or center, bringing into a unity the electrical engineering of all these associations, not restricting, but broadening their work and making them constituent parts of a great whole.

3. There is opportunity for close relations between our local branches and local engineering societies or clubs. In two or three cities the local societies are considering plans of uniting sections of their societies with local branches of the National Societies. Think for a moment of the possibilities in elevating the work and increasing the efficiency of engineering organizations by establishing close ties between local and national societies—keeping them in close sympathy and co-operation and bringing them into one great system! The success which has attended our branch organizations augurs well for further extension by similar methods for awakening and stimulating a general interest in engineering subjects.

4. There should be co-operation—without affecting their present individuality—between national engineering societies in the nature of a National Engineering Congress for promoting closer relations between the various branches of engineering work and for representing the engineering profession as a whole.

In the Union Building for the Engineering Societies it devolves upon the societies to provide the land upon which the Carnegie gift is to be placed. To provide for the Institute in this matter, a committee has undertaken the raising by subscription of a fund for this purpose. This magnificent supplement to what Mr. Carnegie is doing will give the Institute its rent free, its building for library and general meetings, for offices, reading and reception rooms, and the like. This will enable us to devote to technical purposes the funds which would otherwise be required for rent, which are considerable now, and would be greater in the future.

We anticipate substantial contributions from those who have reaped a rich reward from the applications of electricity. Their wealth has come in no small degree from the work of electrical engineers. Whatever the Institute may do in raising the standard and increasing the effectiveness of electrical engineering brings rich returns to those men and particularly those companies commercially interested in electrical pursuits.

We must develop men, broader, more effective men. Let us maintain high standards of excellence, of professional attainment and of integrity. We need not be too exclusive holding ourselves aloof and apart. In religion the ideal is no longer the monk in the cloistered cell, it is activity in daily life. Electrical engineering is in contact with many interests, let electrical engineers be in touch with many men. In one sense engineering and commercialism are widely apart. True, we are not an advertising medium, but we do not discard those papers and those subjects which are of engineering interest and value simply because they may be of financial importance to someone. It is not our function to treat simply of the things which are of no value to anybody. Our criterion is not commercial, but engineering; practical common sense, not sentiment, must prevail in our relations to things and to men.

The engineer is not merely the man in the closet surrounded by slide rules and tables. There is a commercial side to engineering—not mere selling, but the adaptation of engineering work to definite industrial and commercial conditions in such manner as to bring the best results.

Electrical enterprises depend upon manufacturers, industrial captains and financial managers—upon those who construct and apply and use and direct the results of engineering work. It is well for engineers to know these men and to work in harmony with them. The new Union Building—the Capitol of American Engineering—not only brings engineers of different professions together, but it recognizes broader relations. I count it fortunate that the engineering societies will be adjacent to a social club "composed of engineers and others who may be interested in or connected with the engineering profession."

We have a professional standing to maintain and ideals toward which to strive; let us be awake to the times and in touch with modern methods. Let us make the work, the methods and the ideals of our Institute in full harmony with that profession which deals with kinetic energy—and whose units of measure are units of activity and whose mission it is to energize, to operate, to awaken, to unite, to transform and to make effective.

THE LARGEST FREIGHT CAR IN THE WORLD.

The accompanying photograph shows a freight car which for carrying capacity and weight holds the record up to date. The dimensions of this car are as follows: Length of bridge trusses, 66 ft. 10 ins.; height of bridge trusses, 6 ft.; distance between king bolts, 64 ft.; length of car over couplers, 103 ft. 10½ ins.; total height of car, 10 ft. 2¼ ins.; width of car, 9 ft. 9 ins. The weight of the car is 196,420 lbs., and its capacity is 300,000 lbs. The actual weight of the two castings with which the car was loaded, when the photograph was taken, was 277,000 lbs.

THE HEAVIEST FREIGHT CAR EVER BUILT.

This car was built by the Bethlehem Steel Co., of South Bethlehem, Pa., for its own use in shipping the enormous steel castings that it is making. One of the steel castings made by this company weighs 325,000 lbs., and is to form a part of the 12,000-ton forging press for the Carnegie Steel Co. So large a steel casting was probably never made before.

We are indebted to Mr. A. E. Borie, Vice-President Bethlehem Steel Co., for the photograph of the car and the data as to its dimensions.

FINAL REPORT OF SPECIAL COMMISSION ON PLANS FOR THE MANHATTAN BRIDGE.

The use of eye-bar chains for the Manhattan suspension bridge, New York City, has been approved in all particulars by the special commission of engineers appointed last February by Mayor Low. The final report* of the commission is as follows:

New York, June 29, 1903.

Hon. Seth Low, Mayor of the City of New York.

Dear Sir: Having been appointed by your letter of Feb. 10 a commission to pass upon the plans prepared under the direction of the Commissioner of Bridges for the Manhattan Bridge across the East River, we submitted on March 9 a preliminary report covering the principal features of the design. We deferred our final report relating to the quality of the material to be used for the eye-bar cables until additional tests could be had and we should be satisfied by correspondence with the leading manufacturers of structural steel that the desired material could be obtained at reasonable price and in open competition.

Three different manufacturing plants have manufactured and tested nickel-steel bars for the purpose of this investigation.

From the results of the tests submitted to us we are satisfied that material which will meet the requirements hereinafter outlined can be obtained for this bridge.

Our investigation relating to material has been restricted to the special steel best suited for use in eye-bar cables, as this feature of the design under consideration is the main departure from the usual practice in the design of suspension bridges. This investigation satisfied us that a steel of the following qualities in full size annealed eye-bars will be satisfactory:

Ultimate strength, lbs. per sq. in.	85,000
Actual elastic limit, lbs. per sq. in.	48,000
Percentage of elongation in 18 ft.	9
Percentage of reduction at fracture	40

The maximum stress in these eye-bars under actual dead load, combined with the working load of 8,000 lbs. per lin. ft., given in our preliminary report, together with effect of temperature, should not exceed 30,000 lbs. per sq. in.

The tests so far made would indicate that the above results can be obtained by a steel made by the open-hearth process containing 3¼ to 3½% of nickel; containing not over 0.05% of sulphur; not over 0.06% phosphorus if made in an acid furnace, nor over 0.04% if made in a basic furnace.

Three manufacturers with established plants state that they are now prepared to furnish steel to fulfil the above requirements; and others state that they can arrange to furnish it in a reasonable time if the demand warrants them in so doing.

The strength of steel eye-bars having the above qualities will be 50% greater than standard bars now used in the best class of bridge construction; the working strains can therefore be increased in the same proportion.

In our preliminary report of March 9 we reported favorably on all features relating to the design of this bridge, subject only to the uncertainty of obtaining this quality of material. This uncertainty is now removed.

In this final report we unanimously recommend the adoption and execution of the proposed design of the Manhattan Bridge, as submitted to us by the Commissioner of Bridges.

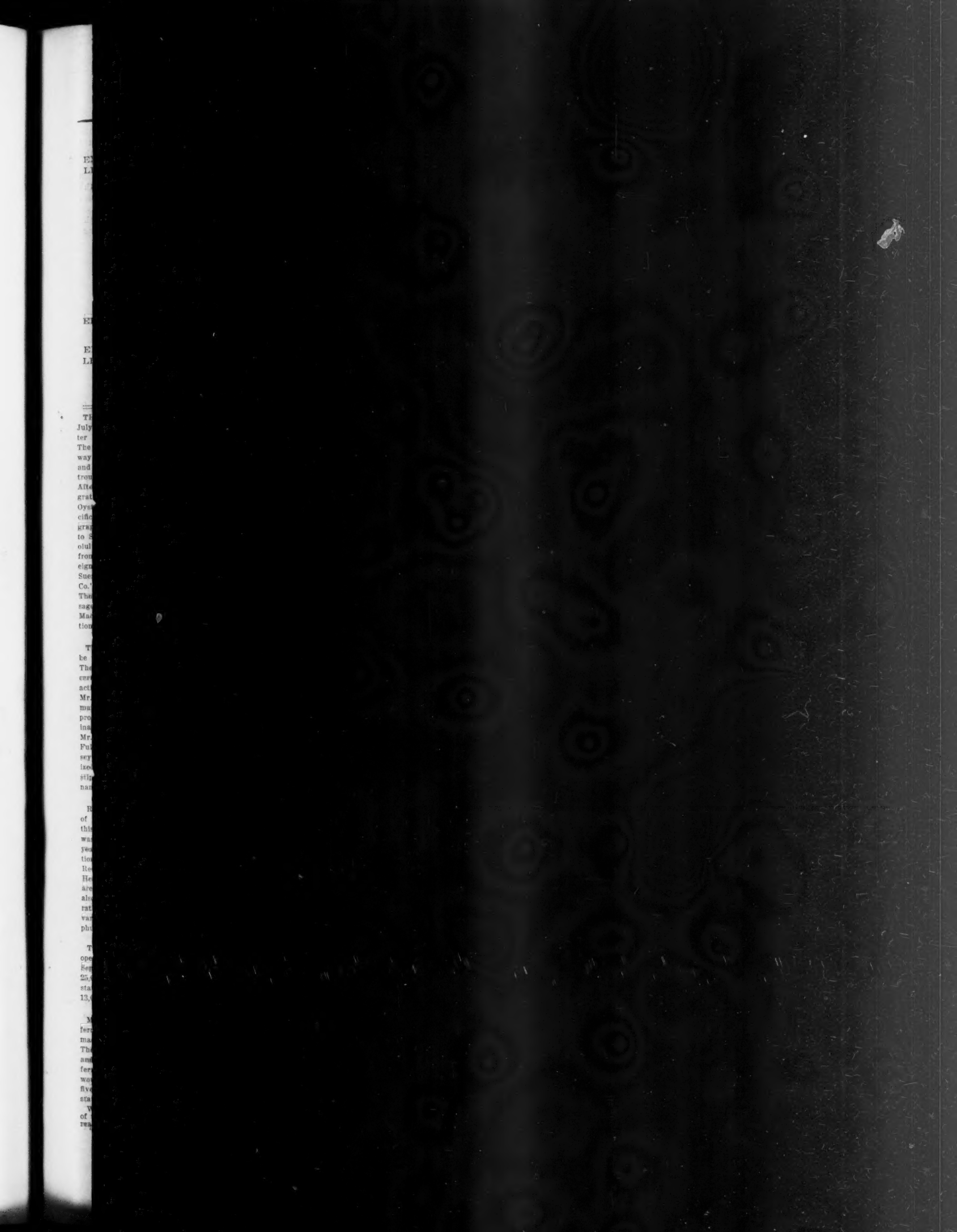
Very respectfully, your obedient servants,

(Signed) Geo. S. Morison, C. C. Schneider, Mansfield Merriman, Henry W. Hodge, Theodore Cooper.

*The prior report was published in Engineering News of March 12, 1903. The plans for the bridge, as submitted by Mr. Gustav Lindenthal, M. Am. Soc. C. E., Commissioner of Bridges, New York City, were described and illustrated in Engineering News of Feb. 19, 1903.

A FIRE-DAMP EXPLOSION killed some two hundred miners, June 30, in Mine No. 1 of the Union Pacific Coal Co., at Hanna, Wyo. More than 250 miners, mostly colored men, were in the workings at the time of the explosion. Mine No. 1 is said to be well ventilated and provided with numerous avenues of escape, but the fire spread so rapidly that the men had no chance to get out.

PARK IMPROVEMENTS AT CHICAGO are to be carried out under an act passed by the last legislature appropriating $4,000,000 for such work. About $1,000,000 of this amount will be expended for land and construction in establishing several small parks and recreation grounds in the more densely populated districts. The remainder will be spent on Grant Park (on the lake front) and for large parks in South Chicago and the town of Lake. Grant Park is being formed by filling in along the lake front, east of the Illinois Central R. R., and a portion is already used as a playground, although in an unfinished condition. About 1,000 acres of new parks will be added to the city's park system by the above-noted extensions. One of the new small parks (McKinley Park, 34 acres), near the stockyards district, was opened recently. This contains the open-air swimming pool described in our issue of May 21, 1903.

INFORMATION REGARDING STREAM POLLUTION is being collected by the New York State Board of Health, in accordance with an act passed by the last legislature.

THE COOLING AND PURIFICATION of air for office buildings is most effectually accomplished by forcing the air through a water spray. The excess of water in the air is then removed by centrifugal force. To do this a series of tubes are provided in which spirals are so placed as to give the air a whirling motion, causing the suspended particles of moisture to be thrown outward, and thus brought into contact with the tubes, from which the moisture flows through perforations to a drip-pan below. By providing a thermostat and steam heating coils it is thus possible to have air at the same temperature throughout the year, and not only to have the same temperature, but the same moisture contents. A plant of this character was recently installed for The Twin City Telephone Co., of St. Paul, Minn., by the B. F. Sturtevant Co., of Boston, Mass.